VOL·V

NO·2

THE JOURNAL OF THE SOCIETY OF AUTOMOTIVE ENGINEERS

S·A·E

AUGUST 1919

SOCIETY OF AUTOMOTIVE ENGINEERS INC
29 WEST 39TH STREET NEW YORK

THE JOURNAL OF THE SOCIETY OF AUTOMOTIVE ENGINEERS

Vol. V August, 1919 No. 2

The Summer Meeting

THE feeling of the members that the meeting of the Society held at Ottawa Beach, Mich., in June, was a great success, appears to be so nearly unanimous as to be remarkable. By "great success" the members mean that they, their wives, children and guests enjoyed themselves hugely. They also feel that the meeting exemplified the function and object of the Society in technical interest and standardization work, to which were added features of recreation and sport that were beneficial as well as entertaining. The meeting afforded an unusual opportunity for the 700 members and guests to relax thoroughly, follow new matters of technical interest and become better acquainted with their fellow workers.

The Meetings Committee and others concerned in the planning and conduct of the meeting deserve much credit. Plans had been completed for the holding of a meeting by the Society at Ottawa Beach some years before. Nevertheless, there was much opposition to it as a meeting place on account of its relative inaccessibility from the standpoint of rail transportation and largely because it was not known at all generally to the members. It developed that the surroundings of the meeting were not only unusually attractive from the scenic standpoint but were well suited to the necessities of the members in the Summer Meeting, where adequate and comfortable quarters for the meeting and general accommodations are essential, with facilities for diversion and entertainment also.

The program of having technical meetings in the morning only, the afternoons and evenings being devoted to sports and semi-popular lectures and dancing, fitted the ideas of the members very well, and was much relished. There was something on the professional program of interest to almost every member, and the bathing, fishing, boating, baseball, golf, tennis and other things, gave all something to do. Nobody was seen who was bored. Nearly all visited the quaint country store regularly; the way in which the ladies enjoyed the croquet and clock golf, as well as the Red Cross lecture, was surprising and edifying.

Standards Committee Meeting

The reports and discussion presented on behalf of various Divisions of the Standards Committee at the meeting of the Committee preceding the sessions of the Society meeting, are given elsewhere in this issue. The volume of recommendations transmitted by the Standards Committee Divisions was about the same as at the last meeting of the Society held at New York in February. Recommendations were made on about the same number of subjects, although the classes of subjects were not at all the same. The Aeronautic Division, for example, made a progress report only.

President Manly, who has continued to act this year as the Chairman of the Aeronautic Division, explained the plans of the Division. After the signing of the armistice there was no longer, of course, immediate necessity for standardization of aeronautic apparatus and equipment for war purposes. The peace-time plans of the Army and of the Navy not having been formulated, and it being impossible to determine upon them until after the taking of action by Congress, the Aeronautic Division of the Society has been completing changes in its standardization program to meet the needs of commercial production and service of aircraft as contrasted with increased military effectiveness. The settlement of Government contracts and the general state of industrial uncertainty have probably affected no field of activity more than that of aircraft production, so that the time has been inopportune for, if not such as to render impossible, concerted effort toward aircraft standardization work during the past several months. The members of the Aeronautic Division have, however, realized the importance of keeping recommended practice as far in advance of production as possible in order to avoid the difficulties of agreement which always attend the correlation of widely diversified, established practices. Probably no joint efforts could be more effective as a guide in securing rational development, ease of production and satisfaction in the use of aircraft than the estab-

lishment and recognition by designers and manufacturers of recommended practices and standards. The Aeronautic Division has at recent meetings assigned to sub-committees various subjects before the Division, in a manner to accomplish the most in a broad way.

Owing to lack of Congressional authority considered necessary, a committee to represent this country has not been appointed to participate in the proceedings of the International Aircraft Standards Commission which was to have held a meeting at Paris several weeks ago. In view, however, of the contemplated international standardization in the aircraft field, the Aeronautic Division of the Society has given particular attention to correlating existing standards in this country and developing definite bases for consideration in international standardization. All available data relating to the subjects on the program of the International Aircraft Standards Commission have been collected, abstracted and digested for convenience in reference and presentation. It has been the policy of the Division to call upon other Divisions of the Standards Committee, to which general subjects are assigned, for action upon those items which apply specially to aeronautic equipment. For example, a thorough comparison of the British Engineering Standards Association specifications for ball and roller bearings for airplanes and the S. A. E. Standard of dimensions for annular ball bearings, has been prepared by the Ball and Roller Bearings Division. Similarly, the Tire and Rim Division has been called upon in connection with the standardization of rims and tires for aeronautic purposes. The Iron and Steel Division has been asked to consider aeronautic steel specifications. Members of other Divisions have prepared recommendations in connection with magnetos and spark-plugs with direct reference to harmonizing our present practice with foreign standards.

The members of the Aeronautic Division have assisted materially in collecting and submitting data for use in compiling the aeronautic handbook which the Society plans to publish later in the year.

The Aeronautic Division has sub-committees at work upon several subjects, including airplane performance tests, sand-load tests of airplanes and their component parts, airplane engine tests, purity of essential ingredients of dopes and cement, turnbuckle fork-ends, swedged and streamline wire ends, and cable loops and fittings.

Treasurer's Report

The Treasurer's report, which was made and accepted, was in the form of a condensed balance sheet as of April 30, 1919. This showed a surplus of $92,367.14, consisting almost entirely of cash on hand of $44,227.19, and investments of $48,022.50. The accounts receivable and accounts payable items were $22,073.96 and $10,011.09 respectively. An inventories item of $5,666.30 was shown; also items of accrued interest, $1,116.81, and of furniture and fixtures, $7,175.23. The reserve set up on the liability side of the balance sheet amounted to $25,903.76.

Membership Matters

Chairman C. C. Hinkley of the Membership Committee reported on the increase in the number of members during the year and on the work of his committee. On June 1, 1919, the total individual membership of the Society was 3960. In addition there were 85 affiliate members, 99 affiliate member representatives and 124 enrolled students, making a total of 4268 individuals and companies enrolled by the Society on June 1. The affiliate member representatives and enrolled students are not, strictly speaking, members of the Society. The total on June 1, 1918, corresponding to the 4268, was 3496. Mr. Hinkley said that a plan was being devised whereby it would be shown each month just what each Section of the Society is doing in the membership increase work. He said that it is the desire of his committee to enlist the efforts of all members of the Society who travel regularly, in the way of advancing generally information as to the work and progress of the Society. The immediate purpose in mind is to secure additional desirable members of the Society.

In connection with the enrollment of associates by the Sections of the Society, Mr. Hinkley expressed the view that a number of these should be members of the Society as well as of the Sections with which they are affiliated at present. The authorization of enrollment of associates by the Sections, through action of the Council of the Society, was based upon the idea of serving those men who were eligible for some form of membership in the Society, but who, for good reasons, could not see their way clear to join for the time being. The Constitution and By-Laws of all of the Sections provide that Section Associates are not members of either the Society or the Section, but are entitled to the privilege of attending Section meetings and to the receipt of any publications issued by the Section. The Section Associates do not receive any of the publications of the Society, that is the parent organization, except its monthly JOURNAL, and they are not included in the Society's Roster. Under authority of the Council of the Society the Sections may enroll associates for 1 yr. That enrollment is purely a matter of discretion on the part of each Section Governing Board. Likewise, enrollment for the succeeding year is in the discretion of the Governing Board of the Section. Section Associates should not be enrolled except in proper cases and should not be continued on the rolls of a Section for succeeding years except in proper cases. A motion proposed by Chairman A. C. Bergmann of the Metropolitan Section was passed, requesting the Sections Committee of the Society to take under advisement the matter of the proportionate number of Section Associates as compared with Section Members that should be enrolled in a Section.

In connection with the increase of membership of the Society there was some discussion of the provisions of the By-Laws of the Society as to the naming of references by applicants for membership, it being thought that the requiring of five members as references constitutes very much of an obstacle in the case of applications from many men. The By-Laws of the Society, which are enacted by its Council, provide that an applicant "shall, if possible, refer to at least five individual members with whom he is acquainted." This is part of B1 of the By-Laws, which is printed on all application forms, as well as B2 thereof, which provides that applicants who may be so situated as not to be personally known to five members of the Society, may be elected by the Council after sufficient evidence has been secured to show that in its opinion the applicant is eligible for admission. It will be understood that there must be a definite basis upon which the alternative provided for in B2 will be acceptable. The common-sense construction of the By-Laws is that the Council of the Society, which acts on applications, should have before it sufficient evidence as to the qualifications of an applicant in the form of written statements of either members or of reputable persons of standing familiar with the education and experience of the applicant. The names of all applicants for mem-

bership are always printed in an issue of THE JOURNAL of the Society before the applications are acted upon by the Council. When it develops, through correspondence or otherwise, that it is not feasible for an applicant to secure five members as references, the transmission of other evidence of qualifications for the consideration of the Council is requested. The matter to be accomplished in the forwarding of applications for membership in this connection is the securing of such written evidence of eligibility as should be in the hands of the Grading Committee and the Council, none of whom may know any given applicant or any of his references, and who should have before them sufficient written evidence to make a recommendation without regard to their personal knowledge of the applicant or the references.

Truck and Fuel Session

First Vice-president B. B. Bachman presided at the Truck and Fuel Section of the Society meeting, at which papers were presented by L. P. Kalb, upon the Relation of Motor Truck Ability to the Trend of Design; by P. W. Klinger on Steel Truck Wheels and Dr. Joseph E. Pogue on The Engine-Fuel Problem. A paper on Rust Prevention, by Edward T. Birdsall, together with discussion by Wm. MacGlashan, J. C. Hunsaker, Russell Huff, N. W. Hanks and P. W. Abbott, was presented by title. The proposed paper on Tests of Truck Axle Worms and Bearings, by K. Heindlhofer, was not presented, having been withdrawn after being placed tentatively on the program.

Mr. Kalb explained that the main point he wished to bring out in his paper is that truck ability costs money; as ability, especially high-gear ability, is increased, ton-mile economy is decreased. Mr. Kalb advocated the use of four-speed transmissions. He emphasized the fact that the use of pneumatic tires on trucks involves changes from the practice of usual truck design. In connection with fuel consumption, H. L. Horning told of a test made with a combination manifold in which the fuel charge was heated considerably, stating that whereas theoretically, from the standpoint of an engine tester, the volumetric efficiency was so greatly reduced as to make the brake horsepower 25 per cent less on the road, the power of the engine actually appeared to be more. In connection with the use of pneumatic tires on trucks, J. E. Hale said that it had been the practice of his company to use more or less standard trucks in equipping them with pneumatic tires but that generally a larger engine was installed for the reason that in running across country and negotiating hills the trucks would have to run more slowly unless they had larger powerplants. He said that his company had been running some trucks without any differential for a year and that this practice looks promising, it not having been established yet that there is more wear on pneumatic tires without a differential. Mr. Hale stated that the mileage secured from the tires on trucks running between Akron and Boston was not highly satisfactory for the reason that the trucks are run on a 24-hr. schedule, the tires, consequently, being very much abused.

In connection with Dr. Pogue's paper, Chairman Bachman reported that as a result of the papers and discussion on the fuel question presented at the Annual Meeting of the Society, the Council had organized a Research Committee. This Committee has given its attention to the fuel problem, an entire day having been spent at Washington in April in discussing various phases of the subject, with resultant progress that was more real than was apparent at the time. At a meeting of the committee held subsequently in New York City, a resolution was, as stated in Dr. Pogue's paper, adopted to the effect that a committee to be known as the Automotive Fuel Committee, composed of representatives of the Government, the Society of Automotive Engineers, the National Automobile Chamber of Commerce, the Motor & Accessory Manufacturers' Association and other organizations interested in the problems involved, should be formed to consider the fuel situation and promote research intended to aid in the problem of insuring an ample supply of engine fuel. Further meetings have been held by the men designated at that time, under the chairmanship of S. A. Miles, in conference with representatives of the oil industry. A committee is now being organized, composed of representatives of the National Automobile Chamber of Commerce, the Motor & Accessory Manufacturers' Association and the Society of Automotive Engineers, to cooperate with a committee to be appointed by

The Hotel Ottawa Where the Sessions Were Held

the oil industry. The work of these committees is to formulate the objectives in the proper handling of the so-called fuel problem.

Dr. Pogue, in closing the discussion of his paper, said that 49 per cent of the bulk of crude oil refined is now converted into fuel oil and a large proportion of that fuel oil is burned under steam boilers because fuel oil is so cheap that it can be used in competition with coal. The only thing that will prevent this economic waste, barring drastic legislation, which is not to be expected, is a rise in the price of fuel oil which will take it out of the realm of competition with coal. Just as soon as the automotive apparatus can burn fuel oil it can economically capture twice as much motive fuel as it now gets under the name of gasoline. Dr. Pogue feels that this phase of the problem is entirely in the hands of the automotive industry. The consensus of opinion in the automotive industry seems to be that if the oil people would only tell them what they are going to get in the way of fuel they could build engines accordingly. Dr. Pogue feels that no progress will be made by waiting for somebody to say what the fuel is going to be. Nobody knows or can determine this without bringing the proper technique to bear in thorough study. Then to a certain extent it can be determined what the changing character of the fuel will be; the fuel will continue to change periodically, in Dr. Pogue's opinion. The problem is that of adapting an evolving engine to an evolving fuel. The problem can

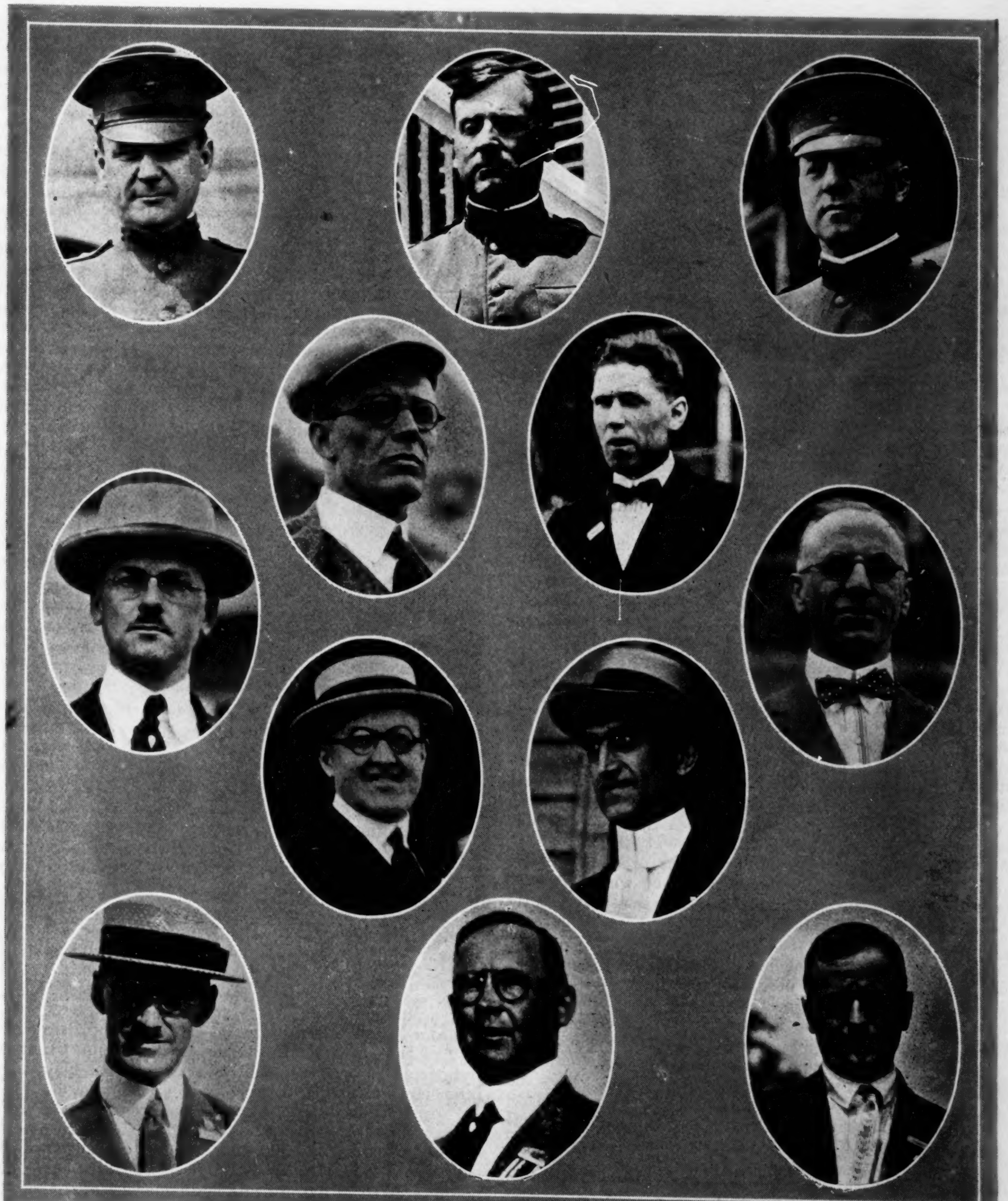
OFFICERS AND PROMINENT MEMBERS WHO WERE PRESENT

Christian Girl — Office Manager Dabney and General Manager Clarkson — J. G. Vincent

Vice-President Bachman — Major Halford

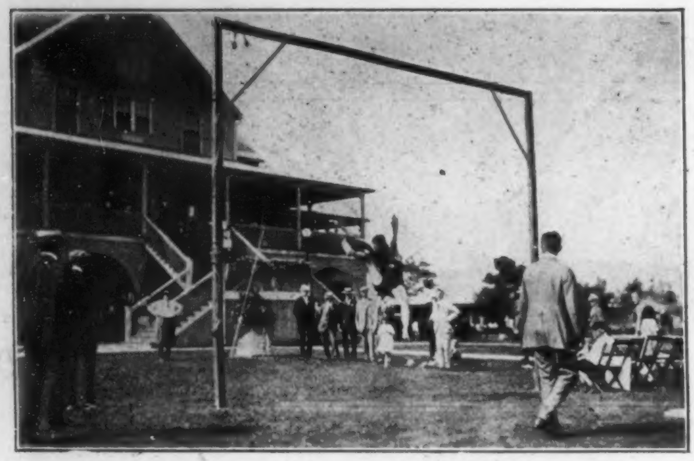
B. G. Koether — President Manly — C. C. Hinkley

Joseph A. Anglada — G. P. Dorris — H. L. Horning



AUTHORS AND SPEAKERS AT THE MEETING

Major-Gen. C. C. Williams
Lieut.-Col. B. F. Miller
Lieut.-Col. A. J. Slade
H. P. MacDonald
Prof. E. A. White
Dr. Joseph E. Pogue
L. P. Kalb
P. W. Klinger
Prof. C. A. Norman
W. B Stout
E. H. Belden
F. C. Goldsmith



ATHLETIC CONTESTS WERE A FEATURE IN THE AFTERNOONS

be solved if it is accorded the attention and investigation its magnitude demands.

Dr. H. C. Dickinson, who has taken a prominent part in the work of the Research Committee of the Society, spoke of the large number of partial solutions of the problem of a shortage, or possible shortage, or reduction in our supply of fuel. The most immediate problem which presents itself is that of the best utilization of the present supply of grades of fuel in the existing equipment. Between 5,000,000 and 6,000,000 passenger cars are running, and a large proportion of them will run for at least 5 yr. Probably a third of all the gasoline is used for passenger cars. From 25 to 30 per cent of the gasoline which goes into the intake manifold at the present time is not doing useful work. Some of it appears in the crankcase. The percentage that goes out in the exhaust is large in comparison. If there were a means of properly burning gasoline in the engines of today, under existing conditions, with no increase in efficiency anywhere else, we could supply effectively 1,000,000 to 2,000,000 more cars than are in operation at this time without increasing the consumption of gasoline at all.

From the research point of view the broader problem involves a number of incidental points on which we have not sufficient information to make the most successful solution of the whole question. Among these is carbonization, and more information about it would be very useful. As the gasoline has contained more and more of heavy ends we have had more and more trouble with so-called pre-ignition, especially with engines of the high-compression type. The Research Committee of the Society has pointed to one specific matter on which data must be obtained, namely, the compression ratio at which it is possible to run various grades of fuel without the pre-ignition difficulty.

If we could burn the kerosene and the lighter fuel oil constituents in trucks, tractors, motor boats, etc., now or within the next year, we would have the problem of the passenger car fairly well solved for some time to come. Whether this would be good economic policy will depend upon the results of research.

PASSENGER CAR SESSION

During the passenger car session Joseph A. Anglada was in the chair.

The occasion was reminiscent of the ideal car session which was a feature of the Cape May meeting of the Society several years ago. The basis for the discussion this year was some statements contributed by E. H. Belden, Henry M. Crane, L. H. Pomeroy, Herbert C. Snow and William B. Stout, the purpose in mind being indicated by the titles of the papers, such as The Future Passenger Car, Torque Recoil and Car Weight, the Passenger Car of the Future and What Motor Cars Could Be.

Harold F. Wood presented a paper entitled Application of Liberty Engine Materials to the Automotive Industry. Mr. Wood advanced the view that the material to be used to secure given physical properties should be that of the mildest composition that can commercially meet the physical property requirements under heat treatment. It has been the practice of a large number of automobile building companies to use high chromium-nickel steels and high-carbon oil-treated steels for a large number of parts. These materials are, of course, satisfactory when extraordinarily high physical properties are essential. Mr. Wood said that for highly stressed bolts, where an elastic limit of about 100,000 lb. per sq. in., with an elongation of 16 and a reduction of area of 50 per cent is required, a very mild steel can be used instead of a material which can be heat-treated to give an elastic limit of 250,000 lb. per sq. in., with good ductility. The thing to be borne in mind in this connection is, of course, a reduction in the cost of the parts. Mr. Wood said that the steels originally specified for the Liberty engine were of the highest quality. It was found that the average company could not produce these materials without a loss of some 15 to 75 per cent, cutting down the engine production greatly. In a modification of the program, fundamental principles were taken into consideration, a strong metallurgical inspection system was established, and the engine production was very satisfactory from the metallurgical standpoint.

In his discussion Dr. John A. Mathews said in reference to Mr. Wood's conclusion as to the use of alloy steels, that he felt that this was an admission of the limitations of the basic open-hearth process for the manufacture of higher alloy steels, at least by most of the makers of basic steels. He said that the higher type of alloys, when well made, gave better physical properties with less radical treatment and that if there is to be progress in the aviation field toward lighter weight and more power the very best steels must be used.

The passenger car session was concluded by the reading by title of a paper by F. C. Goldsmith, entitled Load-Carrying Possibilities of Angular-Contact Ball Bearings.

ARMY AND NAVY SESSION

Major Azel Ames presided at the Army and Navy Session of the meeting, this being of great value from the industrial as well as the Government standpoint and intensely interesting.

President Manly presented the paper entitled Progress in Naval Aircraft, the author, Com. J. C. Hunsaker, being unable to attend. In pointing out the excellence of the paper, Mr. Manly said that it is of great value to any one interested in flying boats and general Naval aircraft, the treatment being thorough, covering little points as well as large matters. Commander Hunsaker's contribution is probably the most complete review that has been made of this topic, the information gleaned being the result of years of development in research and in shop and field practice.

Mr. Manly told of a large flying boat that was built in this country in the winter of 1915. It was a triplane with 130-ft. wing spread; it was equipped with four

300-hp. engines and had a gross weight of 2100 lb. The British Government had ordered a number of these, but before they were delivered the contract was canceled for the reason that it had been decided that a boat of that size was too large. It was thought that it would be too cumbersome and that boats of smaller size would do better work. At that time the Germans had relatively small, quickly maneuverable machines.

Commander Hunsaker is to be commended highly for what he said in the matter of organized engineering. Organization is the greatest thing in the world for getting results. There is nobody who does not make some mistakes, and therefore an organization in which there is a spirit of helpful and constructive criticism is most effective in attaining desired achievements.

In introducing Lieut.-Col. B. F. Miller, who talked on the future of the Motor Transport Corps, Major Ames said that one of the most significant things the war has

THE GOLF LINKS ATTRACTED SOME OF THE MEMBERS

shown is the extent to which the conduct of war is but the adaptation to a military objective of the forces and materials and the organizations of civil life. There is no relation between our fighting forces and organized industry which has been more greatly developed than that concerned in the production of motor transport equipment. Colonel Miller, who spoke on behalf of Brig.-Gen. C. B. Drake, chief of the Motor Transport Corps, referred feelingly to the patriotism of the Society during the war, and announced that the Motor Transport Corps looks forward to the Society for assistance in time of peace. It is most desirable that the military motor vehicle equipment be developed and kept at all times abreast of current practice. It is believed that this will result in much benefit to the public at large, regardless of any possibility of another war.

Capt. John V. Costello of the Air Service, in speaking of the matters involved in the transition from war to peace time occupation, gave assurance of the cooperation of the Engineering Division at Dayton.

ADDRESS OF MAJOR-GEN. C. C. WILLIAMS

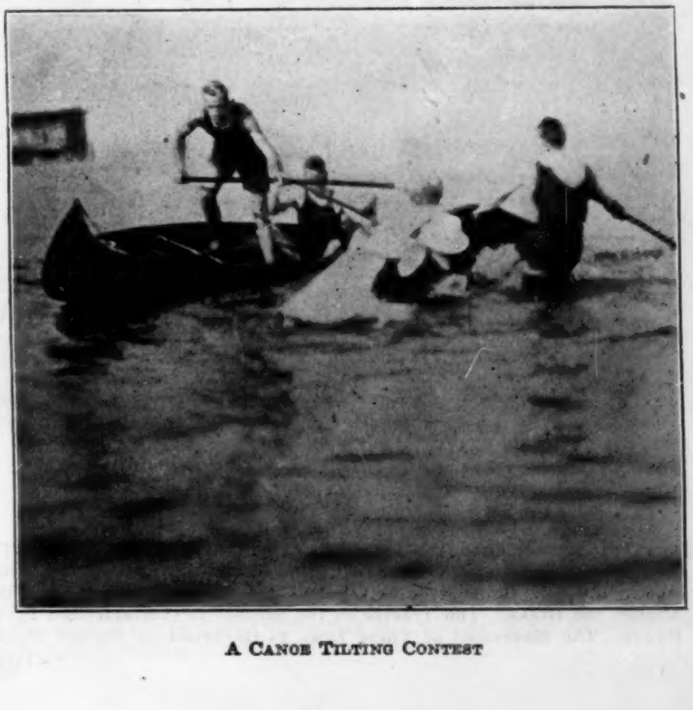
The Society was greatly honored by the presence at the meeting of the Chief of Ordnance of the United States Army, Major-Gen. C. C. Williams, who very graciously said that the object of his visit was to express the debt that the Ordnance Department owes to the Society for its very valuable assistance rendered during the war. The relations which had been established at the beginning of the war were continued throughout its duration. At the very outset a large number of members of the Society were commissioned in the Ordnance Department, and they did fine work all the way through. At the close of the war about 500 men had been commissioned for the automotive service; some of these were scattered throughout the workshops in the United States as well as those in France.

During the period of the war the Ordnance Department motor equipment amounted to some 40,000 vehicles. Many of these were sent to the other side, but the shipping conditions were such that all of them could not be sent.

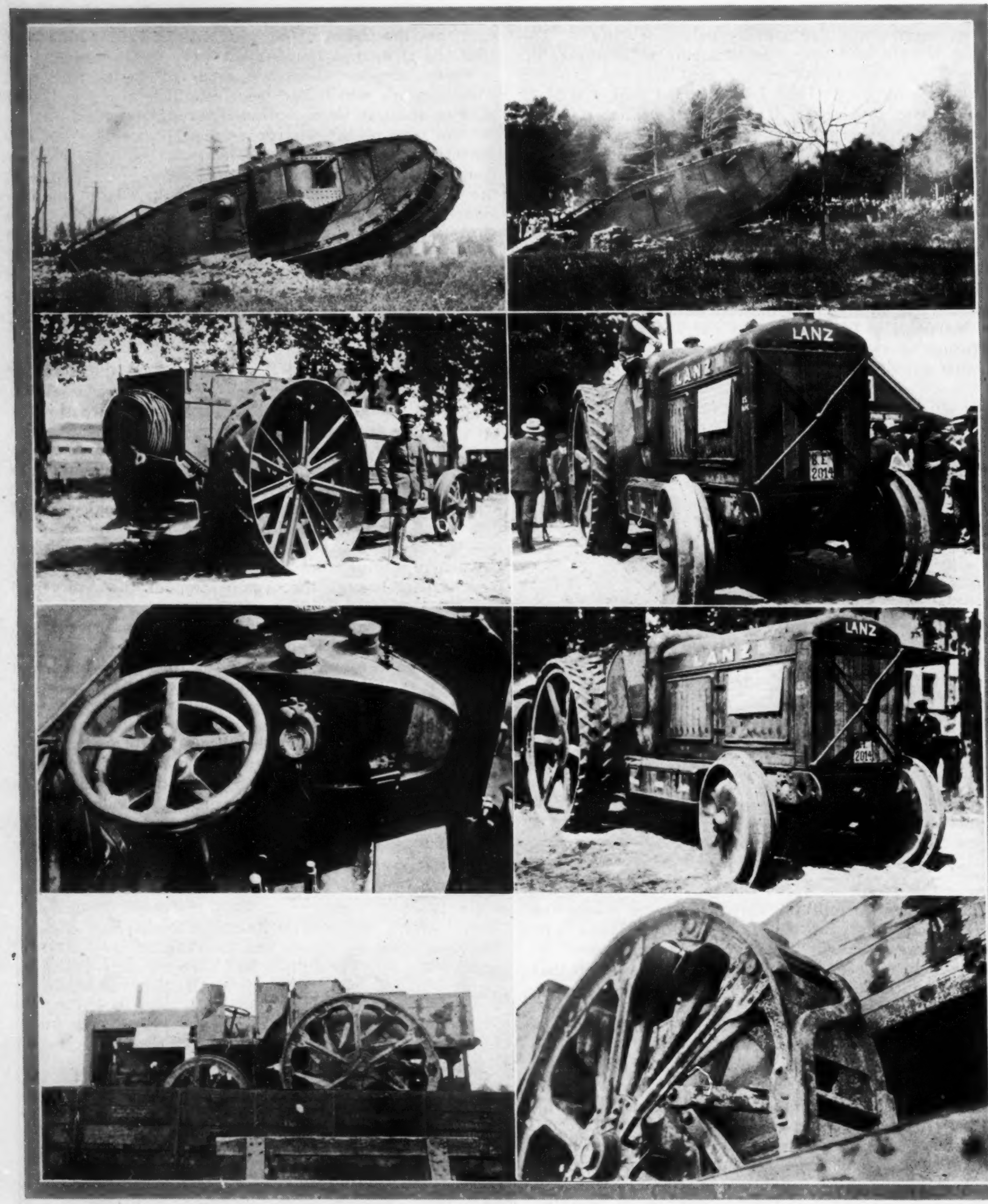
General Williams said that the greatest single factor that appeared in the war was the internal-combustion engine and its derivatives. The airplane, the tractor, the tank and the truck profoundly modified battlefield tactics as a whole. Tactics are dependent entirely upon equipment and organization is dependent upon equipment. The old Roman legion was necessarily dependent upon its arms, which were the short sword and the buckler. That meant one kind of organization. As the power of arms has increased and developed, as the various machines have come into practice in war, it has become absolutely necessary to change the organization of the Army and also the tactics of fighting.

As to motor equipment, the Ordnance Department handles only the special kinds, such as the tank, the tractor, the automobile repair shop and the like. The tank was one of the very important developments of the war. When it first came it was, of course, difficult to get the ordinary military commander to see that it had any value. A few enthusiasts, however, visualized the future and continued to work on the tank in spite of much discouragement. The tank finally gained a foothold, and at the end of the war it had absolutely proved its value.

The Ordnance Department now has under construction tanks of three different types, one the small tank, another

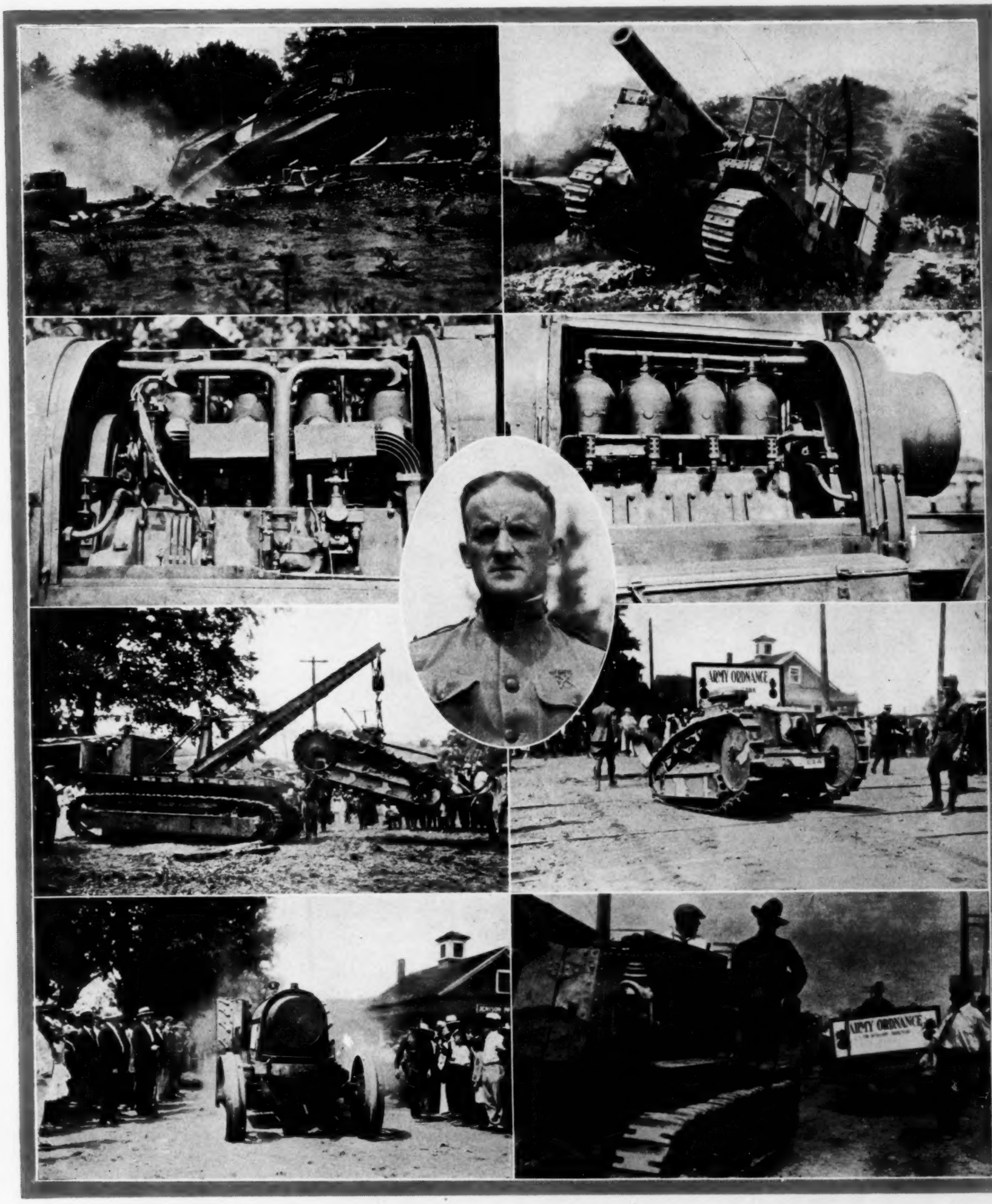


A CANOE TILTING CONTEST



PART OF THE GOVERNMENT EXHIBIT

The Two Views at the Top Show the American Mark VIII Tank. The Next Four Are Views of the Lanz Tractor Which Was Brought Over from Germany. The First of These Shows the Rear of the Tractor and the Way in Which the Haulage Rope Is Coiled Up when Not in Use and Underneath Is Depicted the Control System. The Upper Wheel Is Employed for Steering and the One Underneath Applies the Brake. The Tractor at the Bottom Is Characterized by a Series of Lugs Which Can Be Extended beyond the Face of the Wheel. The Movement of These Lugs Is Governed by the Set of Eccentrics Shown in the Close-Up of the Wheel at the Right



OF AUTOMOTIVE APPARATUS

The View at the Upper Left Corner Shows an English Tank in Action. In the Other Corner Is an American 6-In. Howitzer Tractor. The Engine at the Left of the Next Pair Is That Used on a German Truck and the Opposite One Is That of a Small German Tractor. The Officer in the Center Is Col. L. B. Moody, Who Had Charge of the Exhibit. Underneath Are the 10-Ton Tractor Crane Developed by the Ordnance Department and the Ford Tank. In the Lower Left Corner One of the German Tractors Is Traveling to the Exhibition and in the Other Corner One of the American Tractors Is Towing a 2-Ton Artillery Tractor

the medium-sized tank and the third the large type called Mark VIII. General Williams said that Mark VIII is really the product of Past-president Herbert W. Alden of the Society, who served as a colonel in the Ordnance Department during the war. He paid tribute to the engineering ability of Colonel Alden, who made a preliminary study of tanks in this country in the early days of the war and then went abroad to gather information in preparation for the design of the super-tank, the Mark VIII. The mobile repair shop, which the Ordnance Department used in France, was of great value. There were two sizes, one being called the heavy mobile repair shop. This unit forms a part of the equipment of an artillery brigade, goes with it right into the battle line and is used in the repair of guns and small pieces. General Williams said that these shops made it possible to keep about 98 per cent of the guns in action all the time.

In speaking of the artillery tractor, General Williams said that this was perhaps the most important thing to the Ordnance Department. He believes that it will revolutionize the operations of mobile artillery. He pointed out the controlling influence the horse had on the design of artillery material. All nations have adopted as their principal piece what they call a 75-mm., a 15-pounder or a 3-in. gun. This fires a projectile of about 12 to 15 lb. weight with approximately the same initial velocity and the same range capacity. The reason that all nations have reached this common solution is that 4500 lb. is the maximum weight that can be carried or drawn behind six horses with the degree of mobility required. The carriage on which the gun is mounted, the gun itself and all the features of the design are compromises, the result depending entirely upon the draft power of the horse. Heavier loads can be handled by eight-horse teams with less mobility. The 6-in. howitzer, the 4.7 gun and the like are hauled in this way, but in this work it is necessary to divide the load.

With the use of the tractor the controlling factor is entirely changed. The different nations will, in all probability, find a new solution for the operation of the mobile field gun, the gun that is used in greatest numbers. Our service had 5, 10 and 15-ton tractors in production before the end of the war. Enough of them were delivered abroad to demonstrate to the satisfaction of the Ordnance Department that the tractor is the coming thing so far as artillery is concerned. One method is to use the tractor simply as a pulling machine; the other is to mount the gun directly on the tractor itself. There are advantages in both methods, which are being thoroughly tried.

General Williams said that it had been demonstrated during the war that men, soldiers and officers can be trained to be efficient enough to put up a very good fight in a much shorter time than the material with which to equip them can be built. He called the attention of the members to the vital matter of industrial policy, in which are involved organizations for the manufacturers getting into production quickly when war comes, the conduct of the arsenals and the prompt conversion of the stupendous potential power of this country in manufacturing into the production of war material. It is necessary to know whether full or skeletonized units will be maintained, how the Government is going to be able to keep in close contact with the manufacturers and, in fact, what the organization is going to be from the top down.

In closing his remarks, which the members followed with the greatest interest, General Williams said: "The Ordnance Department appreciates very greatly the assistance which the Society of Automotive Engineers has rendered, and it wants to maintain the same close and cordial relations which it found of such great benefit during the war. We would like very much indeed, and we hope to be able to have Ordnance officers become members of the Society, so that we may constantly keep you in touch with all the problems that confront us and ask your advice on the solution of them. At the present time the law forbids the expenditure of Government funds for the expenses of officers while attending such a meeting as this.

"It is necessary for us to call upon you who have a vastly greater experience in the general line of automotive engineering than we have; we must call upon you for your assistance in solving the many problems that will be presented to us in the future."

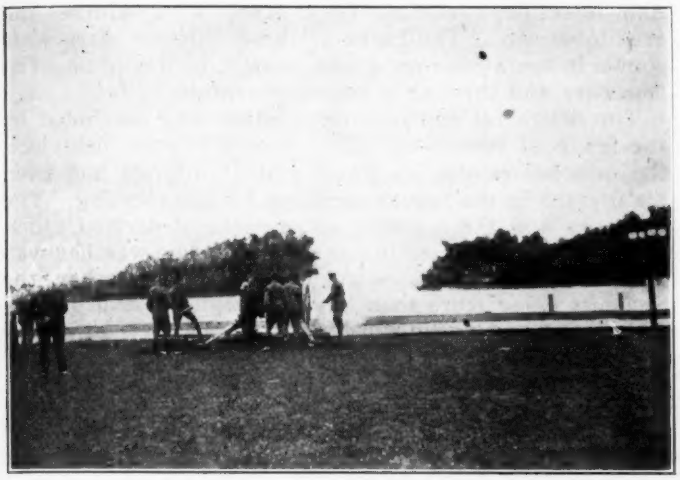
General Williams' address was received with great enthusiasm. Chairman Ames said that the Society had held no session which in interest and in appeal to that attribute of the engineer which is one of his principal characteristics, namely, his spirit of service, was more striking than this one and that the Society was greatly indebted to General Williams for this very gratifying fact.

President Manly, in replying to General Williams, assured him that the Society would cooperate with the Ordnance Department in every way possible, the spirit of the members being to render the best service to the Government.

Engine and Tractor Session

H. L. Horning, in opening the Engine and Tractor Session as chairman pro tempore, called attention to the masterly merit of Prof. C. A. Norman's paper on Working Processes of Future Combustion Engines. The members were absorbed in Professor Norman's clear and forceful remarks on the fundamental engine problem of converting fuel energy into power. He said that if we succeed, as today, in converting only 15 or 20 per cent of the energy supplied into power, we feel a stigma; but it is only after we have become numbed and dulled to this form of activity that we forget the higher ambitions. In the heart there lingers the idea that we must produce an engine that will convert perhaps 50 or more per cent of fuel energy into power. The Diesel engine was a great step in advance, and the Europeans are now working very diligently on its application in automotive work. Professor Norman said that development is proceeding in the same way in this country, and that he felt sure that within 10 yr. there will be developed an engine of the injection type capable of running on any kind of fuel. Professor Norman argued that the present-day combustion engine is inherently complex and unreliable and that, moreover, it cannot utilize without carbonization fuels that are not capable of vaporization.

With relation to the matter of air heating, Professor Norman referred to a paper presented by Professor Berry at a meeting of the American Society of Mechanical Engineers, in which it was shown clearly that it pays to have a wet mixture so far as block test performance is concerned. Professor Norman favors the heated mixture for practical reasons in operation. From the point of view of reliability and the least trouble to the user, in the matter of carbonization, for example, the dry mixture is preferable. Professor Berry advanced the view that it is not necessary to have kerosene perfectly vaporized before the end of the compression stroke. If there is a perfect vapor at the end of the compression



A FEATURE OF THE CLOSING DAY WAS THE FIRING OF THE NATIONAL SALUTE

stroke, that is all that is needed. Professor Norman believes it is better to have the kerosene vaporized perfectly in the manifold. With present-day kerosene with end-point of 550 deg. fahr., a temperature of air of about 450 deg. fahr. is needed. The mixture should have a temperature between 200 and 220 deg. fahr. The corresponding temperatures for gasoline are about 170 for the air and 100 for the mixture. According to tests made by Professor Berry, the wet drops disappeared entirely at 160 deg.

Dealing with possibilities entirely different from those of our present methods of power production, Professor Norman said that, given full rein and a small amount of money, scientists can accomplish wonders. He referred at some length to the possible production of power by electricity directly from combustion. In concluding his paper, in answer to the question whether it would be possible to use the combustion process with ordinary fuels to deliver an electric current in a primary battery and what the fuel utilization of such a battery would be, he said that it can only be stated that as long ago as 1910 some German scientists succeeded in combining such fuel batteries, using materials ranging from hydrogen to sawdust. Electromotive forces close to those theoretically possible were obtained. By burning carbon electrodes considerable currents were obtained without any reduction of the electromotive force.

In presenting his paper entitled The Relation of the Tractor to the Implement, Prof. E. A. White emphasized the point that to continue to advance in its field the farm tractor must be adapted to those mechanisms, that is, the implements with which it is used and which have been developed according to conceptions derived from farming with horses. Summarizing, he said that there are machines on the market which plow, harrow, harvest and cultivate rowed crops but they have decided limitations as to size possibilities for the heavier soil preparation work. On the other hand, the tractor is cumbersome and requires considerable expensive and heavy equipment to enable it to be used efficiently as a hauling implement. It is a slow-speed apparatus. Professor White looks for improvement along four definite lines. First is development as to the quality of the material used in tractors and implements. This he believes is the foundation upon which the future of agricultural implements must be built. The next great step he looks for is increasing the mechanical efficiency of tractors and implements. He feels that the average farm tractor of today is between $7\frac{1}{2}$ and 10 per cent efficient as a motor going through the field. Speed of work is very important from the tractor standpoint, in the opinion of Professor White. He considers it very desirable to increase the rate of farm operation. This matter of speed is relative only; if a two-plow outfit that will work at 3 miles per hr. can be built more cheaply than a three-plow outfit which works at 2 miles per hr., the two-plow outfit is desirable if its engine will furnish power enough for the farmer in operations other than plowing. In connection with one-man operation, Professor White believes that on the average size farm a man must be able not only to ride the tractor but to make necessary operating adjustments while in motion.

Prof. J. L. Mowry, who discussed Professor White's paper at some length, stated that he favors a field speed of 3 to 3.5 miles per hr. He believes that the three and four plow outfits will predominate.

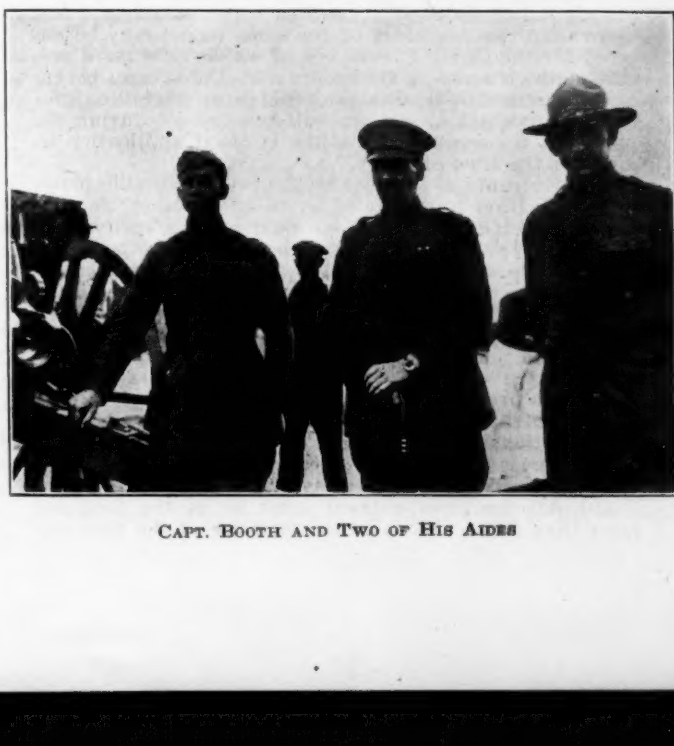
H. P. MacDonald's paper on Electrical Heat Treatment of steel interested the members, as describing novel development in an important field.

EVENING LECTURES

With the afternoons devoted to recreation and sports, the lectures and dances of the evening were well attended and appreciated. The address of E. H. Colpitts, assistant chief engineer of the Western Electric Co., on Wireless Telephony, accompanied by demonstration of transmission to Chicago via a motor boat moored in the lake adjacent to the hotel, made clear a number of the points of the new art about which the members had naturally been curious. The exposition of gas warfare, by Dr. John Johnson, professor of chemistry at Yale University, was also very well received. The members enjoyed heartily the account Lieut.-Col. Arthur J. Slade, U. S. A., gave of his experiences with the American Expeditionary Forces, including his service in charge of the Engineering Section of the Motor Transport Corps and with the Armistice Commission.

EXHIBITION OF AUTOMOTIVE APPARATUS

The Society was very fortunate in being able to have, through the courtesy of the Motor Transport Corps, examples of recent German motor-truck construction for the inspection of the members at the meeting. Six of

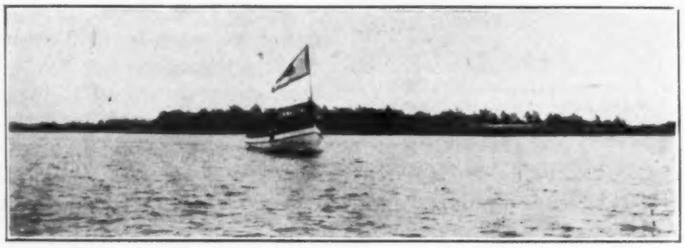


CAPT. BOOTH AND TWO OF HIS AIDES

the trucks used by the Germans during the war, recently brought to this country in the charge of Col. Slade, were transported specially to Ottawa Beach by rail from Camp Holabird, Md. It is expected that a report on engineering details of these and other German trucks, as well as of trucks of French and British manufacture, will be available in due course.

The Society is indebted particularly to the Ordnance Department of the Army for the magnificent exhibit it made of different types of tanks, mobile repair shops, guns, howitzers and other apparatus used in the service. The shipment required thirty freight cars for its haulage to the meeting and was unloaded and placed on exhibition and later demonstrated in a most workmanlike and creditable way. The tanks of three different sizes were shown in operation over rough ground, including negotiation over and through a cellar excavation.

The delightful and historic meeting was concluded by the firing of twenty-one guns from a 75-mm. fieldpiece, the national salute. A great deal of interest had been manifested in the papers prepared for the meeting. The members and their guests all apparently derived much pleasure from the meeting as a whole. The weather was good enough to be called regular S. A. E. weather, the elements being more than kind in providing cool breezes and almost continuous sunshine.



ENGLISH TRACTOR TRIAL REGULATIONS

THE official regulations which will govern the tractor trials to be held in Lincolnshire during September next under the direction of the Society of Motor Manufacturers & Traders are given below.

Regulations

(1) The trial is open to agricultural tractors and self-contained motor plows of all kinds.

(2) Entries shall be made upon special forms to be obtained from the Society of Motor Manufacturers & Traders, Ltd., 83 Pall Mall, S. W. 1, and must be received not later than June 30, 1919, or by July 31 on payment of a late fee of 50 per cent in addition to the entry fee.

(3) The entry fee is £20 for each tractor or self-contained motor plow and £5 for each implement to be drawn.

(4) Entries may be made by manufacturers or concessionaires in this country [England] for manufacturers abroad or by their accredited representatives. Not more than two machines of the same model may be entered for the plowing tests, one of which, or a third machine, which must be similar to the others, may be entered for demonstration of haulage or threshing, facilities for which operations will be provided during the period of the second part of the trials if application be made at the time of entry.

(5) Entrants of tractors must provide suitable plows and cultivators to be hauled by their machines, and entrants of self-contained plows must provide cultivators.

(6) Any proposed entry may be declined without giving any reason, and the judges may prohibit any machine from taking further part in the trials in the event of its not performing to the satisfaction of the judges during the drawbar test.

(7) The judges shall have power to postpone or discontinue the trials in the event of unsuitable weather conditions prevailing.

(8) Entrants shall provide the judges with all necessary particulars of machines entered and shall afford the engineer facilities to verify such particulars and take any measurements he may deem necessary.

(9) All machines entered must be in the field not later than seven o'clock on the morning of the first day of the trials, and from that time the judges will have charge of them. Any late arrivals will be inspected and tested only at the discretion of the judges.

(10) One grade each of gasoline, benzol and paraffin fuel will be provided for machines driven by internal-combustion engines and one grade each of coal and coke for steam-driven machines, but the entrant must declare the class and approximate quantity of fuel required at the date of entry.

(11) All fuel tanks must be provided with means for completely draining off the fuel for measuring purposes.

(12) If a cooling medium other than water is required, a special declaration must be made to the Society of Motor Manufacturers & Traders at the date of entry.

(13) The selling price of each machine current at the date of entry is to be declared by the entrant for inclusion in the catalog, and a guarantee to be given that such price will not be increased for machines delivered within a period of 3 months from the completion of the trials unless justified by advances in wages or materials.

(14) The judges will be appointed by the National Farmers' Union. Tractors or self-contained motor plows and hauled implements will be reported upon independently. With regard to the machines themselves, the judges, in their report, will take into consideration the following points:

(a) Weight of machine in full working order with spuds
(b) Weight per square foot on front and rear wheels separately in the case of a wheeled machine or weight per square foot of track in contact with the ground for a track machien, calculated in each case in a sinkage of 1 in. only
(c) Costs of fuel and lubricating oil per acre, in proportion to the drawbar pull
(d) Water evaporated per acre
(e) Ease of handling including starting time and turning at headlands
(f) Reliability, freedom from mechanical trouble
(g) Capital cost in relation to drawbar pull in pounds

(*h*) Mechanical construction, having special regard to simplicity and access to wearing parts
(*i*) Safety of operation
(*k*) Number of attendants
(*l*) Capacity in acres per day of 8 hr.
(*m*) Efficiency of adhesion
(*n*) Working cost per acre
(*o*) Suitability for haulage and threshing purposes as shown by construction

Implements will be judged on the basis of

(*a*) Construction and operation
(*b*) Adaptability for different widths and depths of plowing or cultivating
(*c*) Quality of work done

(15) All machines will be under observation throughout the period of the trials, and each entrant will, at his own expense, provide an observer for each machine which he enters. The observer's duties will be to watch any machine to which he may be appointed.

(16) Entrants and their representatives and all others attending the trials will be required to abide by the orders of the judges and stewards.

(17) Neither the Society of Motor Manufacturers & Traders nor the judges shall be liable for any loss or damage sustained by an entrant or entrants or others at, or in connection with, the trials.

(18) The judges and stewards are empowered to enforce these regulations and to make and enforce such other regulations as they may deem necessary in connection with, or at, the trials.

(19) The Society of Motor Manufacturers & Tradesr reserves the right to add to, alter, amend or delete any of these regulations.

General Conditions of Trials

The trials will occupy 5 days and will be divided into two parts, as follows:

(*a*) One machine of each make and type entered will be selected and submitted to a drawbar dynamometer test for the purpose of guiding entrants as to how many plows may be drawn by the machine and their size and also for ascertaining the pulling capacity of each machine. These particulars will be obtained by a recording dynamometer when the machine is traveling at 2½ miles per hr. The total gear and ratio of each gear and the driving wheel diameter in the case of a wheeled vehicle or the pitch diameter and pitch of the track sprockets in the case of a track machine must be declared and marked on a label carried on each machine. No structural alterations will be permitted after the drawbar test.

(*b*) The second part of the trial will occupy 3 days; the first by plowing on heavy soil from 10 a. m. to 5 p. m., with a 1-hr. interval; the second day on light soil, and the third day, 2 hr. plowing in the morning and from 2 to 5 p. m. in cultivating land previously plowed.

During the first two days, which will be occupied by the drawbar test, the judges will select at their discretion the machines for this test. After the test the machines may be driven to the place appointed for them to take part in the plowing tests, where they shall stand. They may be covered with tarpaulins and thereafter no repairs, renewals or adjustments may be made to them except by special arrangement with the judges. On the morning of the third day which will be the first of the three devoted to plowing operations and on the morning of each subsequent day, any necessary adjustments must be made during a period of 1 hr. between the first and third signals given, during which period tanks and bunkers must be refilled, etc., and fires may be lighted but there must be no attempt to start engines until the second signal has been given, 10 min. before the third. The third signal is the signal to start actual operations, after which every minute occupied in starting the engine and getting under way will be recorded. During this hour none but the operator or operators normally attending the machines may do any work thereon without penalty. If further assistance is required the machines shall be penalized by recording the number of man-minutes for assistants so employed. On the conclusion of each day of the plowing trials tractors shall run to the end of the furrow then being plowed but shall not enter the plow for a further furrow. No repairs, renewals, or adjustments may be made during the night except by special arrangement with the judges. The regulations as regards preliminary adjustments apply each morning. In the case of steam tractors an extra half hour may be allowed, if demanded, each morning, such extra time being taken in advance of the first signal.

For convenience in conducting the trials, generally, certain areas will be allotted to certain classes of tractors, but all positions on the actual plowing grounds will be balloted for.

COUNCIL OF NATIONAL DEFENSE TO CONTINUE

UNDER the sundry civil service bill the Council of National Defense has had its unexpended balance for the fiscal year ended June 30, 1919, reappropriated to it. Plans are now being matured for the return of the Council to its peacetime functions, which, according to the Act of Congress creating it, are "the coordination of industries and resources for the national security and welfare and the creation of relations that will render possible in time of need the immediate concentration and utilization of the resources of the nation." It is the intention of the Council to collect, study and centralize in a scientific way all information bearing upon the national defense, particularly with regard to the mobilization of industries, science and labor in time of war. With the closing of the work of the Capital Issues Committee, the Committee on Public Information, the Food Administration, the Fuel Administration, the War Industries Board and the War Trade Board, the Council remains the single interdepartmental unit which can centralize the study of the records established by these agencies.

The entire expenses of the Council up to May 1, 1919, were only $1,500,000, this figure including the operations of the War Industries Board for nearly a year and the expenditure of almost $225,000 for erecting a building to house the Council. The committee on supplies of the Council arranged for the purchase of $800,000,000 worth of goods for the Quartermaster Corps of the Army at an expenditure of only $20,000 by the Council, the committee handling 45,000 contracts in 200 days. It is estimated that more than $3,000,000,000 was saved to the Government by the prices which the Council's experts on raw materials, minerals and metals made in the procurement of iron and steel products.

Throughout its war-time work the Council has purposely kept its organization flexible, interfering at no point with the work of the executive departments. It has, on the contrary, been in effect an administrative laboratory and clearing house of study and action in matters touching the national defense. Broadly speaking, it proposes to continue under the same policy, and its plans will be submitted to Congress at or before the regular session in December.

Presidential Address of Charles M. Manly

THE first half of the present year, has no doubt, for a large portion of the members of the Society, been a period of considerable uncertainty as to the immediate future, with probably kaleidoscopic changes in plans. When the whistles blew on the eleventh of last November, announcing the signing of the armistice, the minds and energies of practically the entire membership of the Society were concentrated on the main thing that at that time was worth while, the winning of the war. Instantaneously the situation was changed to one in which an equal concentration of minds and energies was given to the development and production of materials and mechanism for the industries of peace.

It is to the everlasting credit of the American people as a whole that, with so little industrial disturbance, a machine vast and with such enormous momentum as that of our war machine of November, 1918, was so promptly slowed down and quickly unloaded of so much of that which had instantaneously changed from being vitally necessary to extravagantly wasteful.

The statement has been made so frequently that it has probably come to be quite generally accepted without argument, that the recent world war was an engineers' war. The best thing about it is that the victory is won and that all elements and forces worked in wonderful cooperation to achieve the great result. The vitally and immediately important thing to us who are members of this Society having to do with matters of automotive engineering, that newest and most virile main branch of engineering, is that the opportunities and obligations which are knocking at our doors and demanding attention are so great and numerous in connection with the rebuilding and expansion in industrial affairs now on the threshold that we will be laggards and slackers indeed if we do not accelerate our minds and energies to the highest degree for the heavy hill of the world's work which lies ahead of us.

The Problems Before Us

To appreciate the size of some of the problems which lie before us let us take a general survey of the field of automotive engineering. It certainly does not comprise merely the designing and building of automobiles, tractors, aircraft, boats and engines, for none of these can be made to fulfill the demands of the world's work properly unless the automotive engineer who has to do with vehicular transportation goes most thoroughly into the study of the tractive resistance of several kinds of road, the effect of loading, of speed and of different kinds of tire and road, and the reactive effects of the various roads on the vehicles; the pollutive effect of the discharged gases on the air in dense traffic, as well as the effect of drippings from the cars on the road surfaces.

Similarly, the automotive engineer in the tractor field has, besides the general problems connected with vehicular transportation, those of the disruptive and pulverizing resistance of the earth encountered in plowing, harrowing, etc., and the power demanded for the various operations of a general nature to which the powerplant of tractors is applied.

In the aircraft field, the automotive engineer is deeply concerned with the study of meteorology in determining the forces and motions of the air in general, also the internal forces and motions, for the machines must be capable of traveling in their predetermined direction regardless of the speed of the winds encountered and must also be able to withstand the most violent and disruptive internal motions and forces of the most turbulent atmospheric disturbance. Furthermore, the powerplant must function perfectly under the most rapidly changing conditions conceivable, for at one moment the machine may be at ground level and an atmospheric temperature of 100 deg. fahr. or more, and 10 min. later it may be at a 20,000-ft. elevation and a temperature many degrees below zero, where even the human machine cannot function except through the use of compressed oxygen and artificially heated clothing.

In addition to these collateral fields, the automotive engineer in aircraft work must make a special study of textiles, timber, rubber, the chemistry of varnishes, paints, dopes and protective coatings for ferrous metals, as well as metallurgy, both ferrous and non-ferrous. All of these fields must be called on to contribute their proper information, required merely in the designing and building of aircraft to meet the general conditions of operation.

Need for Engineering in Operation

But the work of the automotive engineer is not finished, but merely begun, when the machines are designed and built, whether they be motor trucks, tractors, aircraft or other vehicles. There is more need today for real engineering work in connection with the planning and organization of the operating end of automotive vehicles and machines than there is in connection with the design and construction of them, just as there are more engineers engaged in the operating and maintenance end of railroads than are engaged in the design and construction of locomotives and railroad cars.

In the subdivision of automotive engineering work having to do with motor trucks, the real work of the engineer has hardly as yet been begun. True it is that motor trucks are being sold and are daily hauling thousands of tons of merchandise and general freight, but the careful study and collection of data for accurately predetermining the best operating equipment, organization and personnel to meet given conditions at a definitely predetermined cost has hardly been started. This single phase of automotive engineering presents more problems for the engineer to solve than would be needed if all our records and data in railroad transportation engineering were suddenly swept away and it became necessary to reestablish such data immediately for the determination of proper freight rates.

Similarly, in that newest of the branches of automotive engineering, which is just now in its beginning, but which is destined to grow to be one of the biggest of the brothers in the family of giants springing from the union, under the magic influence of the electric spark, of atmospheric air and petroleum in the internal-combustion engine, the commercial operation of aircraft, the scope and importance of the problems that must be given immediate and careful attention and study by the engineer are so great that I venture the prediction that within the next 10 yr. there will be a larger number of

engineers engaged exclusively on them than there are today in the total membership of this Society.

The past few years have been big years, years of tremendous progress in comparison with the ones that preceded them, and in this progress no profession has played a greater part than that performed by the automotive engineer, but the progress of the coming years is certain to be even greater in comparison with that of the past few years, and I again venture a prediction, that within 20 yr. from the present time there will be a larger number of automotive engineers in this country than there are members today of the entire engineering profession, and I understand that recent estimates place this membership at 60,000. I wish that I had the talent of word artistry to paint for you the wonderful picture that I see of the development and progress that are sure to come in the field of automotive engineering in the next few years. But since this faculty is denied me I must content myself with trying merely to call your attention to what I conceive to be the main factors in enabling this wonderful picture to become a reality; and those factors are diligent research, thorough organization, and chief of all, complete cooperation. The day when the master builder could have a path worn to his door, even though he built his house in the woods, has, I think, sufficiently passed away to make it a dangerous mode of procedure in this day and generation.

What Cooperation Has Accomplished

The big things of the world of today are without doubt being accomplished through cooperation which can never be attained except through organization. The most forceful illustration which we of this generation have had of the value of cooperation and the necessity for complete organization to achieve such cooperation was furnished by the military, naval, industrial and provisioning cooperation of the Allied peoples in the recent world war, and the fate of the arrogant, self-sufficient and selfish professional man who cannot and will not cooperate with his fellow men in the great work of the world is painted in the everlasting picture of a disgraced, despised and beaten Germany, or a loathsome Turkey which tried at the critical moment to pick the winner and now goes down to ignominy and shame where she belongs.

And this brings me to the main point which I wish to urge on you, and that is the importance and value of the Society of Automotive Engineers to you personally. It is the concrete expression of the wonderful spirit of cooperation that exists among the members of this busy branch of the engineering profession. The progress of the Society has been equal to that to which I have already called your attention in the field of automotive engineering. Also the future progress of the Society is destined to be as great in comparison with that of the past years, as that of the field of automotive engineering of the coming years compared with that of those recently past, provided, and only provided, the wonderful spirit of cooperation of the past in the Society is continued for the future, and I am sure it will be. The chief elements contributing to the maintenance of a cooperative spirit are youth, vision and continuity of successful mental application, and while we as individuals cannot expect to always maintain our youth, yet I urge and trust that the average age of membership in the Society may always remain under that critical age at which the upper limit is said to generally be for the years of greatest creative effort.

There has been in the past some criticism of our Society on the score that the requirements for membership are less as to professional qualifications than those of some of the older engineering societies. This criticism has, however, been more than stilled by the achievements of the Society, which has done more to show the importance and economic value of standardization, both to the producer and to the consumer, than any other single organization in the world.

The views of the Society have been, and I trust they will ever remain, liberal and democratic as to what are the qualifications that entitle a man to membership and classification as an engineer. The basis heretofore has been achievement in the application of scientific or common-sense principles in the design or of materials in the construction or of scientific or common-sense principles in the organization and operation of complete automotive vehicles or their component parts in contributing toward the accomplishment of the world's work, rather than on the basis of how much time has been spent, or how great distress a man has passed through, either in the way of recognized courses of instruction, or professional association or apprenticeship. The most dangerous disease that can affect any organization of professional men is that arising from the growth of an aristocracy or inner circle within the organization, and nothing is so sure to promote such growth as the establishment of qualifications to some high degree of membership, where a man must either have grown crabbed through too constant application to his work, or is likely to have one foot in the grave before he can reasonably expect to attain it.

Research and Standardization

There are two subjects of great importance to the future of automotive engineering to which I would draw your attention. One is research and the other is standardization. Exceedingly important problems are demanding the most vigorous and thorough research work, which in some cases is likely to require large capital expenditures. It is my own personal feeling that the Society as an organization should not attempt to conduct scientific research in the solution of these problems, but that it should act through its professional papers and publications to disseminate the results of such research carried out by its own members or those of other organizations or free lances, and also collect and distribute as full information as possible regarding the publication in other mediums of the results of such research. The function of a research committee would, under such a plan be more that of calling attention to the important problems requiring research and suggesting the location and degree of availability of apparatus with which to conduct such work.

In the matter of standardization, the results already achieved by the Society, while extremely important and of a real pioneer nature, are small as compared with those yet to be attained. The fundamental guiding star which has kept this work of the Society in such a clear and smooth road, that of refusing to permit its standardization work to in any way interfere with or limit real freedom in the important elements of design, should be kept clearly in view in the coming work before it and in the work of international standardization in which the Society should and must take a leading part. In this work of international standardization in the automotive field, my attention has been more definitely concentrated on the subdivision of aircraft work. In this branch of the

work I feel that the most important thing for early consideration is the standardization of those factors and means for determining them, which have to do with safety of operation, not only as it affects the occupants of the machine but also of the people and things of value over which the machine may pass. I refer particularly to the standardization of sand-load tests of the supporting and controlling surfaces and other main units of the machines, so that the meaning of the term "factor of safety" will be uniform internationally. Similarly, the standardization of performance tests should be early agreed upon internationally. Inflammability tests, both for planes and balloons, should also be given early consideration. In fact, the main features that affect uniformity of license for operation and insurance should be given first attention, for it is readily appreciated that the confusion, loss and inconvenience would be beyond description if marine vessels which were licensed and insured as being properly safe in the harbors of one country were prohibited from entering the harbors of another country because their standards of insurance and license were entirely different.

Our Responsibilities and Obligations

I have referred to the wonderful opportunities which are now, and will, in the coming years, be constantly knocking at our door, but opportunity is always accompanied by responsibility and obligation. Our responsibilities and obligations are now and will hereafter be no less than our opportunities. We as professional men have now, and must continue to have, a very real great responsibility toward the Government, both Federal and State, and the public in general. If the wonderful opportunities before the automotive engineer are to be realized fully, there is certain to be hundreds of millions of dollars of public funds expended in the coming years on the building of roads and highways for land transportation and of landing fields and stations for aerial transportation, and it is the duty and obligation of the automotive engineer, as a professional man, to see that the expenditure of public funds in the field in which he is qualified to advise the public is not permitted to be grossly wasted or misappropriated through the inefficiency or selfish greed of those having charge of the administration of such funds, without his giving some of his time and attention to awakening the public to such waste or misappropriation.

Similarly, the automotive engineer has an equal obligation to protest, and cooperate with others in protesting, against legislation that may be attempted or consummated that would tend to retard the fullest realization of the coming wonders of automotive transportation. The wonder of today is the commonplace of tomorrow, and neither restrictive legislation nor selfish greed have as yet aided in the accomplishment of the wonders which have been wrought, but both keep closely behind all advancement seeking to throttle or monopolize its benefits at the first opportunity.

EXTRA-HIGH CANDLEPOWER PROJECTORS

PREVIOUS improvements in the efficiency of searchlights have been in the direction of increased optical effect. A German experimenter has, however, experimented to increase the specific surface luminosity of the searchlight arc-lamp and has been able to attain a searchlight efficiency of five times that hitherto obtained with the same current consumption and optical arrangements.

Instead of using the ordinary 38-mm. diameter pure carbons, he employed high-efficiency carbons 16 mm. in diameter. The negative carbon is arranged obliquely upward opposite the horizontal positive, which is 11 mm. in diameter. The carbon ends are played upon by a flat spirit flame which cools the incandescent ends of the carbon, as the passage of the current is no longer limited to the ends but reaches the inner parts of the carbons. This causes a considerable increase in the temperature of the carbon crater, and the latter burns very deeply into the thin carbon rod, giving a small, round and intensely bright crater opening which, when projected, appears as a circular luminous disk and has a much higher specific luminous intensity than the usual large but flat crater in the ordinary type of projector. The energy consumption is much better, as the voltage with a current of 150 amp. is not 60 volts as ordinarily but reaches 75 to 80 volts. In practice the carbons are kept in constant rotation by a small electric motor to ensure even burning. To keep the crater of the positive carbon in the focus of the parabolic mirror the carbon is displaced by an electromagnetic device with the aid of a selenium cell. Experiments made by Prof. Wedding show the candlepower of such searchlights to attain 500,000,000 cp. It should be possible with the new system to construct very compact searchlights of high candlepower. —*Electrotechnische Zeitschrift, Zeitschrift des Oesterreichischer Ingenieur und Architekten Vereines.*

COMING DEVELOPMENTS IN THE GERMAN IRON INDUSTRY

HOW German engineers and manufacturers propose to deal with the new difficulties of the industry consequent on the war is shown by the report of the managing director of the Iron Founders' Association read at a recent general meeting in Berlin.

The report says that the scarcity of raw materials will continue far into the years of peace. The industry must, therefore, prepare for an intensive use of materials and human intelligence. With the instructive experience in war time in mind the latest scientific knowledge must be applied to the problems of smelting, casting and cooling and to the production of other qualities by the use of new alloys and new means arising out of increased chemical knowledge. Other forms of raw material, more economical methods of burning fuel, improved construction of furnaces and more effective temperatures invite research and suggest progress in new directions. The Kaiser Wilhelm Institute for research in iron has been founded to deal with these problems, and a sister institute for research in other metals is soon to follow. From both of these the iron-foundry industry is hoping for much help. Aluminum and zinc in their various possible combinations will replace copper and nickel and their alloys. The future importance of these metals for Germany can hardly be over-rated. New forms of construction will reduce the consumption of the rarer metals for certain parts of machines. The iron founder will look to the chemist to remedy the evil of a lack of hematite. A number of German blast furnaces are already prepared to use the phosphorus-free ores of Scandinavia and other countries in place of the supposed indispensable hematite. The scientific training and the knowledge imparted in special schools must be extended and utilized. Ways have been opened to a great advance in all branches of the metal industry. Success lies in specializing and cooperation.—*Giesserei-Zeitung.*

REPORT OF JUNE COUNCIL MEETINGS

AT the meeting of the Council held June 23, 1919, at Ottawa Beach, Mich., President Manly, Vice-presidents Bachman and Keilholtz and Councilors Beecroft, De Waters and Whitbeck were present. Statements of profit and loss and of assets and liabilities as of April 30 were submitted showing a profit for the first seven months of the current fiscal year of $29,101.02.

Christian Girl, chairman of the show committee for the Motor & Accessory Manufacturers' Association, and M. L. Heminway, general manager of that Association, attended the meeting to take part in the discussion of the proposal that materials and parts for automotive apparatus should be exhibited at Summer Meetings of the Society in the future. An extended discussion was had. A report was made on about a score of letters received from various members of the Society in answer to a letter from the Society office to the members asking for comment. The sentiment expressed in these replies was two to one against the exhibits being made as indicated, but it was considered that the replies were not representative of the membership of the Society. Practically all of those present favored giving further serious consideration to the holding of the exhibits. There was considerable sentiment in favor of the Society conducting a properly controlled show of articles of interest to the members in a novel way, it being felt that there is at present no event of the kind which meets the actual demand for an occasion where engineers concerned in the design and production of automotive apparatus and parts and materials therefor have opportunity to confer at the time of a general gathering. It was expected that the matter would be discussed at the meeting of the Society to be held the same evening, the Meetings Committee being scheduled to report on a future policy with respect to parts and accessory exhibits at summer meetings.

The Council approved ninety-two applications for individual membership and four for affiliate membership. The following transfers of membership were made:

Associate to Member Grade Arthur A. Frank, John W. Powelson and Henry Tiedemann.

Junior to Member Grade Carl H. Bowen.

The applications of eleven men who "qualified" by payment of dues more than 3 months after election were reapproved and the applicants reassigned to the grades to which they were originally assigned.

The resignations of Charles E. Hathaway, Thomas W. Keating, Ralph W. Makutchan, Ralph H. Rosenberg, F. C. Schwedtman, E. Milton White, W. W. Wuchter and the Bijur Motor Appliance Co. were accepted.

It was reported that 464 membership applications had been received from Jan. 1 to June 17 as compared with 312 for the same period of 1918.

Chairman Bachman reported the action taken by the Standards Committee during the day on recommendations as to Standards and Recommended Practices made to it by various Divisions of the Committee. The recommendations accepted by the Standards Committee were approved by the Council for submission to the Society in meeting assembled during the evening, except in the case of the recommendation as to tractor and stationary engine rating.

It was reported that there had been discussion for some time by various members as to the advisability of establishing a Wheel Division of the Standards Committee. Affirmative action in this respect had been urged, although not very definitely, by members taking active part in the proceedings of the Automotive Wood Wheel Manufacturers Association and of the Automotive Metal Wheel Manufacturers Association. Some of the matters which would naturally fall within the jurisdiction of a Wheel Division have been handled by the Tire and Rim Division. The latter Division has, however, requested that it be relieved of work in connection with any matters relating to tires and wheels which are involved in construction inside of the permanent metal felloe band. The Council decided to hold in abeyance the matter of establishing a Wheel Division until further advices shall be received as to just what is needed and can be done by such a division.

A. J. Scaife was appointed a member of the Standards Committee with assignment to the Springs Division. The following were named as members of the Marine Division for this year, Joseph Van Blerck having been previously appointed and having accepted the chairmanship thereof:

F. S. Duesenberg	Henry R. Sutphen
E. T. Larkin	Kirk W. Dyer
A. F. Milbrath	George F. Crouch
E. A. Riotte	John J. Amory

The following items of work were assigned:

AERONAUTIC DIVISION
- Airplane Performance Tests
- Sand-Load Tests

ELECTRICAL EQUIPMENT DIVISION
- Barrel Mounting for Generators

ENGINE DIVISION
- Governor Drive Mounting

LIGHTING DIVISION
- Side Lamp Glasses

MISCELLANEOUS DIVISION
- Fuel Vacuum-Tank Mounting
- Fuel Vacuum-Tank Connections

SHAFT FITTINGS DIVISION
- Taper Spline Fittings

TIRE AND RIM DIVISION
- Tires for Trailers

The Research Committee reported that a meeting had been held during the afternoon and that the Committee would report to the Society during the meeting as to the general procedure and the conduct of special research by the Bureau of Standards as outlined by the Committee. The matter of the Society appointing a member of the Automotive Conference Committee to confer with representatives of the oil industry was referred to Chairman Bachman and General Manager Clarkson with power.

At the meeting of the Council held at Ottawa Beach, Mich., on June 27, President Manly, Vice-presidents Bachman, Belden and Keilholtz and Councilor Beecroft were present. A communication from Dr. S. W. Stratton, chairman of the National Screw Thread Commission, requesting that the Society appoint at least one member to accompany the Commission on a visit to Europe, was considered. It was explained that E. H. Ehrman and H. T. Herr who had been nominated as members of the Commission by the Society, were unable to make the trip with the Commission. The Council decided that Walter C. Baker and H. L. Horning should be appointed to accompany the Commission to Europe and that in the event of either declining, President Manly and General Manager Clarkson be empowered to appoint another representative of the Society in the connection. [Earle Buckingham was subsequently appointed in Mr. Baker's place.]

It was reported that owing to lack of opportunity the Meetings Committee had not reported at the meeting of the Society held on the evening of June 23, on the future policy with respect to parts and accessory exhibits at Summer Meetings. The matter was left in the hands of the Meetings Committee.

With relation to the discussion at the business session of

the Society on June 23 as to officers of the Army joining the Society, General Manager Clarkson was directed to consult Major-General C. C. Williams, chief of ordnance, as to conferring with the Secretary of War on the subject. It was understood that the General Manager would confer with Major-General Williams and others as to the establishment of a Military Division of the Society as suggested by Past-president Dunham. It was the opinion of the Council that additional information should be secured from Lieut.-Col. Arthur J. Slade as to his idea of forming an educational committee on transport.

The next meeting of the Council will be held at New York City in September unless otherwise ordered by President Manly.

THE FUTURE OF TRANSATLANTIC FLYING[1]

I WISH to express a word of appreciation to the host, the American Flying Club, and tell in a general way of how we were received abroad. Everywhere we went we were treated as though we were great personages. They gave us luncheons and dinners and there were other events. Two countries decorated us. Every new place we went crowds awaited us, including reporters and moving-picture machines. It was all very novel and unusual for all of us, and we appreciated and enjoyed it very much; but nobody ever appreciates such demonstrations from strangers in strange lands as much as he does the indications of approval from his own country. That is the reason we mean it more when we say here that we appreciate the welcome than when we have said it before.

I should like to congratulate the people who are responsible for the design and construction and workmanship of the NC machine.

Regarding the Liberty engine, previous to the flight I personally had had very little experience with it. But after making this flight and watching the way the engine of this type ran, particularly during the long night from Trepassey to the Azores, when every exhaust was spouting out its flame without a miss, my faith and confidence in the Liberty engine has mounted very high.

One of the chief facts gathered regarding the structure of the seaplane is that the future machine built for long distance flight should be enormously larger than the NC boats, hich have a 126-ft. wing span. The design will undoubtedly incorporate a gearing-down from the engine to the propeller and the connecting up of several engines to drive one large propeller.

I wish every success to Capt. Roy N. Francis, who I understand is to attempt the transcontinental flight, using Liberty engines. While no one likes to prophesy regarding the outcome of flights nowadays, I fully believe that the chances of success are as great with the Liberty engine as they would be with any engine.

The results obtained by the radio officer on the NC-4 undoubtedly broke many previous records. He sent messages over 700 miles. He heard Boston talking over 1000 nautical miles. He copied a long message sent from the George Washington when approaching Brest, France, 1175 miles away. He heard stations calling other stations 1300 miles away. Considering the requirements of a radio installation on our comparatively small seaplane, this was really a marvelous performance. The radio compass also proved itself of the greatest value. Before starting on the flight, preliminary experiments at Rockaway apparently indicated that not much dependence could be placed on the radio compass; in a test flight which I had made in another type of seaplane, the results obtained were unsatisfactory. In fact, I placed no dependence on the installation when starting on the trip. Owing to this fact I almost forgot we had such an instrument aboard and did not really try to use it until after leaving Ponta Delgada. On that trip, owing to an error in the compass, the NC-4 wandered considerably off the course. It was the radio compass that brought us back again to our line of destroyers, before I had discovered the cause of the compass error and corrected it. The average distance from the destroyers at which we could obtain results with this radio compass was 30 or 40 miles. I look to the radio compass for the solution of the navigation problem of transatlantic flying.

The most tangible result of the flight is the immense amount of information obtained concerning the seaplanes themselves and their operation over the sea for long distances. The obtaining of that information was the chief reason for undertaking the project. I will not try to appraise the more intangible results of increasing prestige to the Navy and to the country or of demonstrating that the transatlantic flight can be made.

My general impression from the flight was that the Atlantic Ocean had shrunk greatly in size. No matter how much we figure speeds, distances and elapsed time, it is not really brought home to us what an enormous saving in time is effected by flying instead of steaming across the ocean, until we actually do it.

My chief impression of Lisbon was of the great friendliness of the Portuguese people for anything and everything American. I was surprised at the Azores Islands by the feeling that the people as a whole bore toward us. In England the sportsmanship of the British, who had hoped to capture the prize of the first ocean flight for themselves, was conspicuous.

The French are enthusiastic about anything connected with flying. In England also there is the same enthusiasm not only in the general attitude but in accomplishing things for the future development of the art.

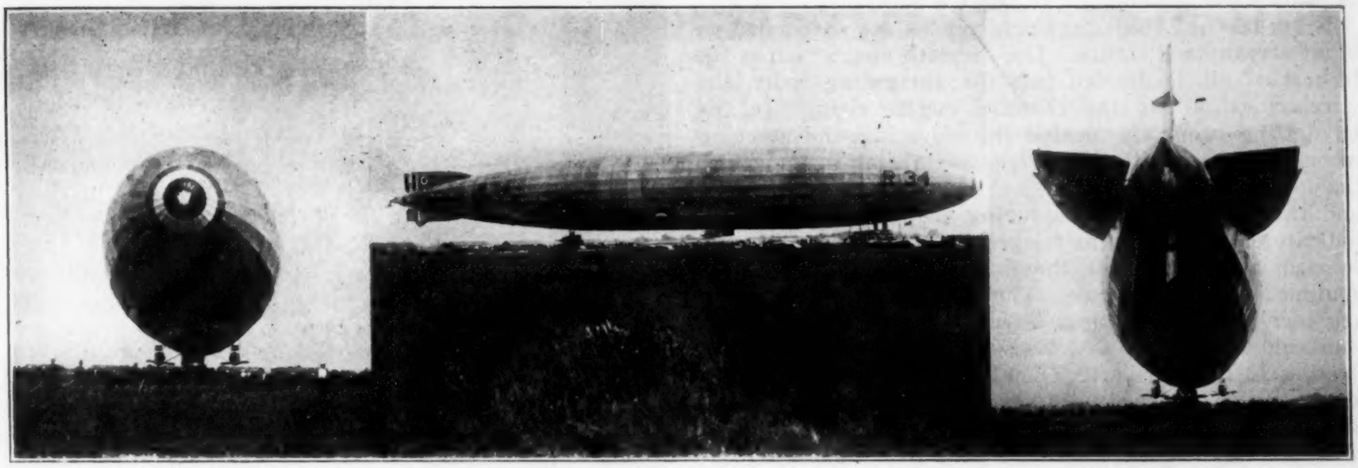
I was astonished upon returning to the United States to find that the proper feeling toward aviation is lacking to a considerable extent. It seems to be the general thought here that aviation will take care of itself. It is a thought similar to that held after the first submarine made its initial plunge successfully and after the Wright brothers made their first successful flight. But aviation is not an art that will advance by itself. I believe that if we could have the hearty cooperation in aviation that we had during the war, within 3 yr. we would be sending our families back and forth across the Atlantic by air. There is an enormous field of development still open.

In Paris I had the pleasure of meeting some of the foremost designers of aircraft. Some of the things they said will happen in the future would appear so visionary to most people at this time that I am afraid to repeat them. Anyone, however, who says that we will never climb to an altitude of 60,000 ft., that we will never be able to cross to Europe in the forenoon and return in the afternoon, that we will never be able to accomplish things that appear impossible now, is as courageous as those who in the old days said that iron ships would not float.

I am a great believer in getting behind civilian aviation projects. All the arguments for a merchant marine hold in the case of a merchant air force, and there is much greater reason for the encouragement of the merchant air force. When the people realize the things we fliers and those who have studied the question realize, they will get behind the proposition in the way the British have always been behind creating a large and powerful navy and are now behind creating an enormous air force.

[1] From a speech delivered by Lieut.-Com. Albert C. Read, U. S. N., at a dinner in honor of the crews of the NC flying boats who participated in the first transatlantic flight. Commander Read was in command of the NC-4, the first flying boat to cross the Atlantic successfully.

BOW, SIDE AND STERN VIEWS OF THE R-34, MOORED AT MINEOLA, N. Y.

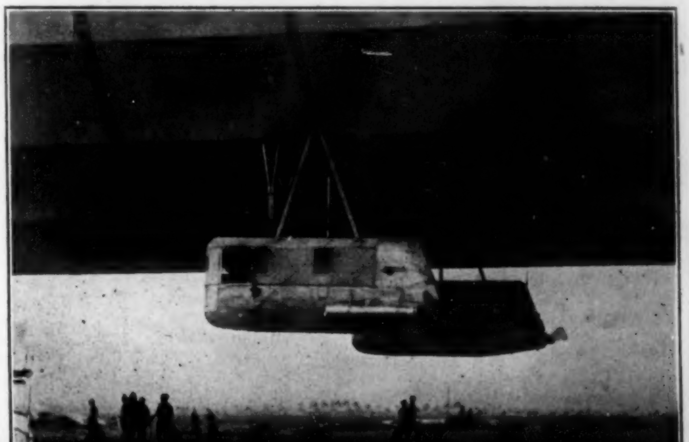


The Trip of the R-34

ONCE more the Atlantic Ocean has been crossed by an aircraft. This time it was the British dirigible R-34, which made the flight from East Fortune, near Edinburgh, Scotland, to Mineola, N. Y., via Newfoundland, a distance of 3180 miles in 108 hr., 12 min. The ship left East Fortune, Scotland, early in the morning of July 2, and landed at Hazelhurst Field, Mineola, N. Y., on the morning of July 6. The wind was favorable for the crossing at the beginning of the flight, but strong headwinds were soon encountered so that the airship had to fight practically all the way over to Newfoundland. Upon reaching this side of the Atlantic, the air conditions were so unfavorable at one time that landing at Boston was considered. The wind, however, shifted, and the ship was able to complete the flight.

MAJOR C. H. SCOTT, COMMANDER OF THE R-34

The R-34 was launched on March 14, 1919, at the Inchinnan airdrome, where it was built by Wm. Beardmore & Co., Ltd., Glasgow, according to designs of the British Admiralty. The ship is a dirigible of the rigid class, of which the Zeppelin is the prototype. Its length is 680 ft., and the diameter 79 ft. The hull framework is composed of longitudinal and transverse duralumin girders, crossing one another at right angles, and the bays thus formed are trussed with wire stays. The girders are of lattice construction, being built up of the three corner rails and web pieces of an X cross-section. An A-shaped keel running from end to end at the bottom of the hull provides a passageway between the cars, as well as affording access to the platforms on the top of the hull. The eighty-one gasoline tanks, having a capacity of 71 gal. each, are located in this keel, together with the lubricating oil supply for the engines, the water ballast, food and drinking water and the living quarters for the officers and men. Radial wire trusses at the transverse frames provide athwartship bracing for the hull and form the partitions which separate the nineteen gas bags, which are made of balloon fabric lined with goldbeater's skin. A doped waterproof fabric, which is laced on the hull in sections, forms the outer covering. The tail planes consist of horizontal and vertical fins, with hinged flaps for elevating and steering, and are trussed to the hull by wire stays. The framework of these planes is composed



THE MIDDLE GONDOLAS WHICH ARE EQUIPPED AS ENGINE ROOMS

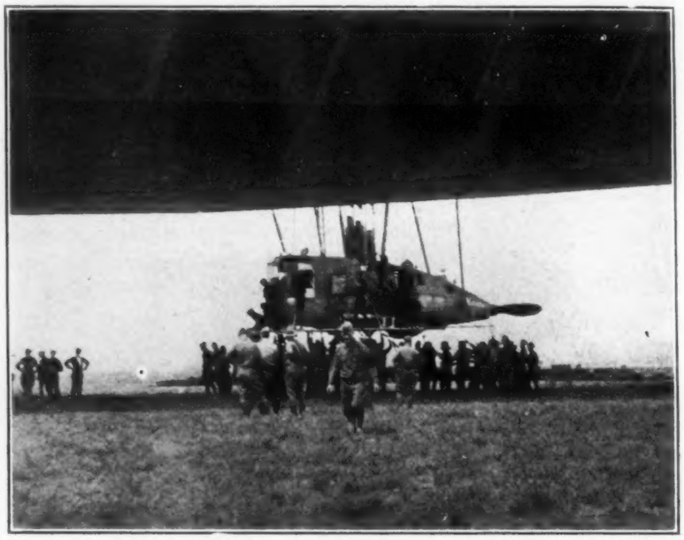
of lattice girders similar to those employed in the hull.

From the hull, four cars or gondolas are suspended on stout streamlined struts. The forward one, which is the largest of all, is divided into the navigating room, the wireless cabin and the forward engine room. In the navigating room are located the elevating and steering wheels, together with the various navigating instruments, including gages for indicating the pressure of the gas and thermometers for measuring its temperature, level indicators and the engine telegraphs. Two wing cars are located amidships and these, like the after one, are equipped as engine rooms. The front and wing gondolas are each equipped with a Maori-4 engine, built by the Sunbeam Motor Car Co., Wolverhampton, England, and driving 16-ft. propellers. The after car, however, is much larger, being equipped with two engines arranged in tandem. Clutches are provided to enable either or both of these engines to drive a 19½-ft. propeller. A locking device is provided for all four propellers to hold them in a horizontal position when the engines are stopped and protect them against possible injury from the ground.

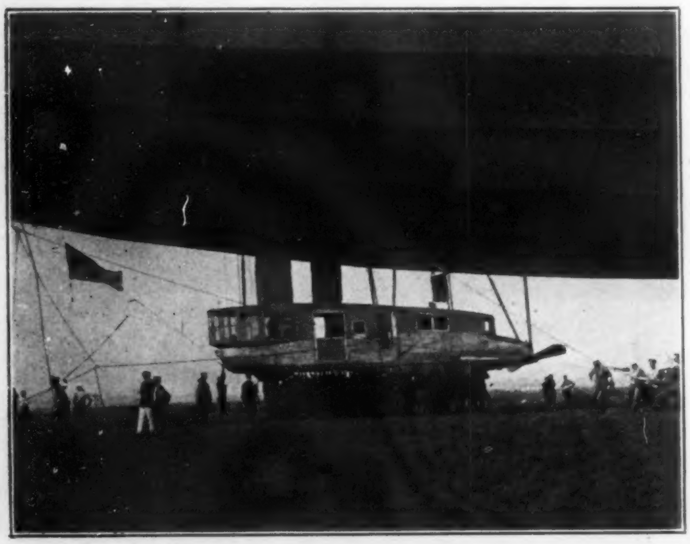
The engines are of the twelve-cylinder type and were specially designed for this class of service. The cylinders, which are arranged in two rows of six each in a V-form at an angle of 60 deg., have a bore of 3.94 in. (110 mm.) and a stroke of 5.31 in. (135 mm.). The engines are designed to run at a speed of 2100 r.p.m., and develop a normal brake horsepower at this speed of 265, the maximum of 280 b.hp. being developed at 2200 r.p.m. Each engine cylinder has four overhead valves, two inlet and two exhaust, actuated by two camshafts to each row of cylinders, the shafts in turn being driven by a train of gears. The articulated system of connecting rods is employed and a flywheel is fitted to the crankshaft.

This flywheel carries one element of a friction clutch which is driven from it by a series of composite leather and brass driving pieces, which are interposed to equalize the strain on the teeth of the main wheels. The clutch proper is of the multiple-disk type, with a single central spring and consists of a series of ten phosphor-bronze plates, making frictional contact with ten similar steel plates. The power is transmitted from the clutch by an intermediate shaft, fitted with a dog coupling for permanent disengagement to a gearbox.

The gearboxes are fitted to the after end of each car and three different types are used. That in the forward car is of the plain reduction type without a reverse gear to step the speed of the crankshaft down from 2100 to 540 r.p.m., the propeller speed. Reversing type gearboxes are used on the wing cars, the rate of reduction being the same. Sliding gears enable the direction of rotation of the propeller to be changed for maneuvering purposes. A special gearbox employing two pinions, both of which engage with a common spur wheel attached to the propeller, is fitted to the after gondola. The details of all the gearboxes are the same, the large-diameter gear wheels being casehardened and fitted with pumps to provide a constant supply of lubricant to the teeth and the bearings.



THE REAR GONDOLA OR MAIN ENGINE ROOM, CONTAINING TWO ENGINES CONNECTED TO A 19½-FT. PROPELLER



THE FORWARD GONDOLA WHICH CONTAINS THE NAVIGATING QUARTERS AND AN ENGINE ROOM

Four Claudel Hobson B. Z. S. 38-type carbureters are provided, each supplying three cylinders. These are located outside the V, and the gasoline is fed to them either by gravity or by pressure. Two twelve-cylinder magnetos, which are geared to run at one and one-half times the crankshaft speed, provide the ignition current. When the engine speed reaches 2500 r.p.m., the governor cuts off the ignition.

Aluminum piping connects the radiators with the engine and an aluminum tank in the hull of the ship. A hoist, which permits the height of the radiator above the car to be regulated, is provided to adjust the cooling area of the radiator to suit the temperature of the surrounding air and the speed of the engine. The water-pump employed in connection with the radiator is of specially large dimensions. Special oil cooling tanks located outside the gondolas communicate with the oil circuit on the engines through a series of connections having indicating plates, so that the amount of oil passing the coolers can be adjusted to suit the running and temperature conditions.

The following table gives the general characteristics of the R-34:

Capacity, cu. ft.	2,000,000
Number of gas bags	19
Overall length, ft.	680
Maximum diameter, ft.	79
Overall height, ft.	92
Gross lift, tons	68
Disposable lift, tons	25
Total power, hp.	1375
Maximum speed, miles per hr.	75

General Fundamentals of Rigid Airship Design

By R. H. Upson[1] (*Member*)

Illustrated with Photograph

RIGID airships have made good. One may still criticize the rigid principle of design, but the double crossing of the Atlantic by the R-34 no one can deny. This unique system of construction developed by the energy and resources of a single man, was long ago taken up by a certain ambitious Government which early realized the importance of pushing the design to the limit, if at all. These airships have become indispensable in the operation of a large fleet, and in this respect the leadership in practical operation over sea has now passed to another country.

British design in general is based on information obtained about German Zeppelins, principally from those which have been brought down in England and France. The English designers admit very frankly they have been mainly copying German practice and that they are still behind what is probably the latest development in Germany. As one high officer expressed it, "We are as far behind them in airship construction as they are behind us in battleship construction." Nevertheless, the recent performance of the R-34 and other British rigid airships show remarkable progress in every way. There is much of value to be taken from present British practice, which seems, at least, to have reached a point where the superiority of the German airships is largely a matter of refinement and development along fundamental lines that are now common to both countries. In addition, the British are also branching out into distinctly original lines of development.

Purpose and Advantages

Rigid airships are intended primarily for cooperation with the fleet over long distances and to a lesser extent for convoy work. Ordinary submarine patrol near the coasts is delegated by common consent to the non-rigid craft. The advantages of airships over large airplanes for cooperation with the fleet are so generally recognized that they need not be mentioned here. The advantages of the rigid over the non-rigid type for this purpose are quoted as follows from the statements of various authorities connected with rigid design and operation:

(1) Easier to control and maneuver than a non-rigid airship of equal size

(2) No need to watch the pressure

(3) No building up of pressure at the high end when tilted

(4) Sub-division into compartments makes for increased safety

(5) Large proportion, over 50 per cent of the total in the latest ships, of useful lift

(6) The rigid type offers convenient attachment for multiple powerplants and propellers at such points as will distribute the load uniformly and prevent undue interference between various propellers

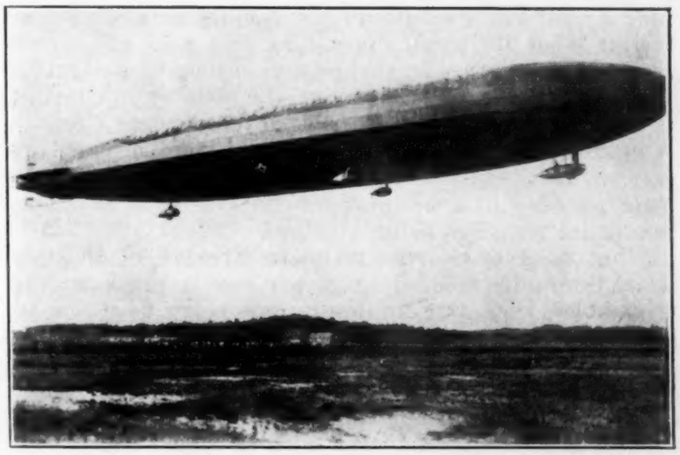
(7) It eliminates a large amount of external cordage and fittings

(8) Convenient access may be had during flight to any important part of the structure

(9) Rigid construction offers great possibilities for sizes much larger than any now in use [The R-34 is 2,000,000 cu. ft. and the latest Zeppelin is about 3,000,000 cu. ft. Already there are plans under way in England and Germany for ships up to 10,000,000 cu. ft. in volume. The largest American airship is 180,000 cu. ft.]

(10) For commercial use the rigid construction offers possibilities for passenger accommodation more substantial than in non-rigid types now in use

In further comment on the above items, it must be said in all fairness that many of them are not inherent in the rigid principle of the design so much as in the way these particular ships happen to be built. For the ship to lift at all, there has to be a very light and fine construction throughout. This general type of construction is naturally extended to include the fins and cars where the weight is probably less than half and the resistance is also small



A Typical Example of Recent Zeppelin Airship Construction

for the size, compared with present types of non-rigid fins and cars. Likewise, to get a large useful lift there is a great refinement of construction in respect to the distribution of material. Thus, there are several different kinds of beams and columns built from various sections of which there are several different standards, and in the finished structure there is a very large variety with respect to the length, strength and distribution of the various elements. If one-half as much pains were taken with the material in a non-rigid envelope, the gain in load-carrying efficiency would be considerable.

To prevent loss of gas and deterioration in quality which would otherwise result from the multiple-unit envelope, the interior balloons are made of goldbeater's skin spread on a 2-oz. cotton cloth which is very light but with a diffusion of only about 2 liters. This fabric is expensive and takes a long time to prepare, but with proper protection from the weather there is no fundamental reason why it should not be used with equal advantage in other types of ships.

Refinement is made in the powerplants and propellers

[1]Aeronautical engineer, Goodyear Tire & Rubber Co., Akron, Ohio.

to an extent unthought of in the non-rigid ships. Many other advantages often cited for rigid airships, such as range of action, carrying capacity and speed may be more properly given as characteristics pertaining simply to large airships. Nevertheless, the rigid or Zeppelin construction is the only one which has to this date been used for sizes upward of 1,000,000 cu. ft. Hence, it is still the only generally recognized construction for large sizes and as such must play a large part in the development of the immediate future.

General Principles of Framing

Every structural member subject to compression is built as far as possible so that it will be about at its critical point between secondary and primary failure. A column under such conditions has a certain proper length for each type of internal construction. If this construction is kept the same and the length increased, the failure on a compression test will be what is called primary, that is, the whole column will tend to bend and buckle. If tested shorter than this critical length, however, the column will fail internally. This same principle here described for the design of a main column would apply to the internal members composing that column. In an ideal column this would have the result of causing all internal members to fail by direct compression. All internal members are designed so that they have approximately equal strength under such conditions and give a uniform strength to the column as a whole, no matter what its length, providing this does not exceed the critical length. In the general system of design for any part, after ascertaining that the member in question is under or near its critical length, its ultimate strength is assumed to be that of the straight parallel members only without regard to the lattice or cross members. The main parallels of a beam or column are rolled to shape, the lattice members being stamped.

What is otherwise the ultimate strength of the material is usually reduced by 20 per cent to allow for the rivet holes, thus, the duralumin now being used has an ultimate strength of 25 tons, but in practice only 20 tons is allowed. This is further subject, of course, to a factor of safety which in case of any definitely known worst conditions is two. This is in the case, for instance, where some accident happens such as would necessitate the deflation of one or two compartments. Under ordinary running conditions, it is aimed to have a factor of at least four throughout the structure.

The specific gravity of duralumin is about 3.0, which makes it equivalent in value to steel of 146,000-lb. strength. The weight of the lattice members and the rivets comprise about 40 per cent of the total weight of duralumin columns, such as are used for main longitudinal members. Wood instead of duralumin was used in the construction of two ships in England. This was found rather treacherous as several parts were broken during flight under various conditions. When made of equal strength, the wood construction is slightly heavier than the duralumin and has the property of being much more flexible. During flight, the whole ship is said to bend quite perceptibly. This feature is not looked upon as desirable, although it is hard to say what disadvantage it can be in itself.

Commander Campbell, chief British designer, regards steel as unquestionably the material of the future for larger sizes. If they were going to build any more small airships of say 1,000,000-cu. ft. volume, he would be inclined to use wood, but for the larger sizes, 5,000,000 cu. ft. or more, he regards steel as the more efficient. High-grade steel is well known to be lighter for the same strength than anything else. The only reason it is not used for present sizes is because its high specific gravity makes it necessary to use such very thin sections.

Fabric

The internal balloons of the rigid ship are invariably made from goldbeater's skin and cloth in the following proportion:

Material	Weight per Square Meter, g.
Cloth	65
Rubber	20
Cement	20
Goldbeater's Skin[2]	30
Varnish[2]	5
Total (Average)	140

[2] The weight is variable.

The diffusion commonly runs as low as from 1 to 2 liters per sq. m., which is a very excellent result for the weight of fabric involved. The actual gas holding properties of the ships themselves are also extremely good. The disadvantage of the goldbeater's skin is that it takes such a huge number of animals to make a single balloon, and the skins have to be put through a rather complicated process of washing, scraping, drying, etc., to prevent decay. It is also said that this skin does not stand up very long under direct exposure to the weather. Attempts are being made in the laboratories to discover a substitute for goldbeater's skin which will have its good properties and yet be more satisfactory and dependable in other respects. An effective chemical substitute has not yet been produced, although encouraging results have been obtained with various glycerine and dope compounds.

The difficulty of supply will be somewhat modified by a recent discovery that there are other parts of the animal which may be made to serve the purpose practically as well as the true goldbeater's skin. The poor resistance to exposure is taken care of by the protective fabric covering over the outside of the hull as used on the typical rigid airship.

The outside covering is composed as follows:

Material	Weight per Square Meter, g.
Varnish	10
Dope	35
Cloth	85
Total (Average)	130

The finish of the present covering is a kind of shiny green which is a rather good camouflage against the ground and also does not show very distinctly against the sky at night. It is reported unsatisfactory as regards durability and radiation properties since it absorbs a considerable amount of heat and ultimately transmits this to the gas. It seems the latter fault could readily be counteracted by proper ventilation of the outside air space, but apparently there has been no special attempt made to do this. It is proposed to try an aluminum finish somewhat similar to the non-rigid envelopes next.

In general, the huge amount of fabric in one of these ships makes it of the utmost importance to save weight in every way possible. An avoidable increase of even a few grams per square meter is quite serious. The strength of fabric required cannot be well computed except from the results of experience. The internal gas bags must stand a maximum pressure at the top due to the head of gas plus about 10 mm., which is the usual

opening pressure for the valves. It is not right to assume, however, that the fabric takes all of this pressure as the gas bags are confined by other structural elements. Chafing on the gas film is minimized by putting this in the inside. The sharp corners of the framing and the wires are also well protected by suitable wrapping. The earlier ships also had a light netting to help hold the internal fabric in place, but this has recently been abandoned in favor of cords tied back and forth in the framing.

A General Comparison of Construction

The simplest comparison that can be made between a non-rigid and a rigid envelope is to imagine a beam which is required to stand a certain bending moment. The effect of the gas lift may then be evaded by considering the fabric beam merely inflated with air. Under such conditions, the following general propositions hold:

(1) The maximum moment which can be put on a properly designed fabric beam without tearing it is equal to one-half the moment required to buckle it

(2) A rigid beam of similar size will carry twice the moment of a fabric beam of the same unit strength

In practice, however, the second proposition is modified by the following factors:

(1) It is possible to obtain materials much stronger in tension than in compression. Drawn wire, for instance, may be had of a strength running from two to three times the best known compressive strength for the same weight

(2) Any purely rigid structure is built up of internal members of which the compression members must be necessarily of a complex nature to avoid buckling. This necessitates a weight for the compression members nearly double what would otherwise be required to carry pure compression alone

The net result of the theoretical basis above assumed would make a rigid beam somewhat heavier for the same strength than a flexible one. Another and still further factor, however, tends to reverse the result once more in its practical application. The two beams, as above assumed, are taken to be cylindrical in form and built of uniform material throughout. The latter would be necessary in the case of the fabric beam because the tension due to internal pressure is at all points the dominating one. In the case of the rigid beam, however, it is clear that proper refinement of design will permit cutting down the weight and strength of the structural elements toward the end of the beam where the bending moment is least. In other words, if a purely non-rigid beam, or balloon, is to resist certain maximum moments and forces of more or less local application, the whole beam must be subjected to the strain of an internal pressure which is determined by the conditions at these critical points. It might be suggested that by the use of internal compartments, a higher pressure could be carried in certain parts of the balloon than in others. This is a possibility, but involves so many undesirable features that it seems of doubtful practicability, at least for sizes now in use.

The only other solution to the general problem is the so-called semi-rigid construction, as exemplified by nearly all of the Italian balloons. This term "semi-rigid" has been loosely used at times to apply to any kind of compromise between a purely non-rigid and rigid construction. Here, however, I shall use the term to apply to a distinct type of construction, which is essentially different in principle from either the non-rigid or rigid. This does not, of course, prevent all these systems being used simultaneously in a single balloon, as, for instance, in the Forlanini type.

The purely semi-rigid construction may be defined as one which depends on internal pressure for nothing except to prevent the internal compression members from buckling. These members can then be made lighter, simpler and more compact than in the case of a purely rigid structure. In general the use of the semi-rigid construction so far as possible would seem to give most of the advantages of the pure rigid type without its principal disadvantage. There are many points, however, at which the semi-rigid construction is clearly not so effective as one of the others:

(1) The nose can be most effectively stiffened by a pure rigid construction

(2) On small ships which can be made quite short, without having the diameter unduly large, the non-rigid construction in general is obviously most convenient

(3) The larger a ship becomes, the longer it has to be made to keep down its weight. This necessitates progressively greater stiffness which justifies the employment of increasingly more of the rigid elements

(4) The powerplants on large, high-speed ships will need special attention as to bracing to distribute the thrust and torque properly

(5) If a rigid structure is used for passenger accommodations, it may be placed so as to form a structural element in the ship as a whole

It is doubtful, however, whether there is any practical size of dirigible which needs or should be made entirely rigid. The best design will always be that which combines proper proportions of all three principles to the best advantage for the particular size and requirements of the airship under consideration.

Conclusion

All things considered, the Zeppelin airship is admittedly the most advanced of any yet constructed. This is taking into account its size, detail features of design, and methods of handling. It is a product of over 20 yr. of work involving the active encouragement and financial support from the German government and the best engineering talent in the country. The present Zeppelin is the same in fundamental construction but a truly immense improvement from a performance standpoint over the original creations of Count Zeppelin. The designers may have been handicapped by the necessity of adhering to this particular type of construction, but great gains were made possible by the way in which development was pushed, particularly in building much larger sizes than any one else had attempted. This not only gave to the "Super-Zeppelins" the huge aerodynamical advantages which accompany an increase in size, but it also permitted the utilization of those ultra refinements in construction which alone have made possible the splendid overall efficiency of the present Zeppelins.

The broad lesson to be gained from British and German experience is obviously this: We should lose no time in starting development of the Zeppelin type ship, but we should also study other types of foreign ships and continue to work out our own systems of construction which promise so much for the future.

The Demands of a Victorious Automotive Nation

By Walter T. Fishleigh[1] (*Member*)

Detroit Section Paper

FROM April 6, 1917, to Nov. 11, 1918, has been the most intense and most far-reaching educational period in the history of the United States. In this short 19 months, results have been accomplished, problems have been solved, lessons have been learned, philosophies and ethics established, which, were it not for their accomplishment in fact, would have been and would still be termed "visionary," "impractical," "impossible." The school of war is a terrible one, and even with such limited participation as it was our fortune to take, its sacrifices in material, effort, hopes and blood have been everlastingly impressed upon us. In spite of our successes, our confidence of power and the justice of our cause, the period of the war has been one long hour of anxiety and of trouble for this nation. And the nation, like the individual in such an hour, turns instinctively toward the fundamentals in life, toward simple and certain principles and ideals which, above all, make life worth living. In the tremendous war struggle, the soldier clerk, the soldier college football player, the soldier actor and the soldier minister alike grope feverishly about them and above them for simple principles and ideals and a philosophy of simple fundamentals upon which to base their courage and their faith in the presence of the extreme sacrifice. It is no coward; indeed, it is the strong man and the strong nation which demand broad and solid and everlasting foundations upon which to stand in war.

It has been the expected result that we, as a nation and as individuals, have been thinking hard and constructively during this world war. We have progressed and developed remarkably in this period of maximum readjustment and of maximum sacrifice. The private, the officer, the congressman, the manufacturer, the workman, the engineer, the educator, the preacher, each is today looking upon this world and peace-time life with its little peace-time struggles, from an elevation absolutely different from 2 yr. ago. Each has learned large and important lessons in relative values and simple justice, and his further actions, both individual and concerted, must of necessity be based thereon.

The war being over, there is both opportunity and danger ahead. There is opportunity, if properly and promptly seized, of the greatest constructive period of our history. There should be the greatest prosperity and progress, onward and upward, commercially, educationally, morally. On the other hand, there is some danger of "breaking training" after the style of the old-time "rough neck" athlete, following the last victorious football game of the season. In a comparatively short time, it is not impossible to destroy the benefits and repudiate the lessons of the training and the sacrifice and the victory.

Post-War Opportunities and Demands

As automotive manufacturers, engineers and educators, we have large responsibilities and opportunities in this post-war reconstruction and industrial rehabilitation, and a frank discussion of two or three prime demands and opportunities which this victorious automotive nation has placed before us should be of value. Pointed and definite discussion and suggestion is, of course, in order and in our present mood, straight-from-the-shoulder criticism must not give way to "pussyfooting" and soft words, when only the former can accomplish the desired results. Constructively, it may be best not to worry too much about the far distant future but rather to face those demands and opportunities which appear directly ahead of us, and in which we see immediate practicability of results.

As a victorious nation, there is no need to debate the fact that we have mastered great lessons and taken giant strides forward in the last 2 yr. Knowledge we have today which might have taken decades to acquire; power we have today which might never otherwise have been developed. Knowledge is power, and both knowledge and power imply responsibility. Responsibility, first, for a part in the situation as it stands; second, for facing squarely the problems before us; third, for the solution of these problems fairly, unselfishly and in the best interests of public and national success.

The lessons and problems which this war and this victory have brought us are so broad and so far-reaching that terminology, even for expressing them correctly, is not easy. Nor is it easy to isolate any particular phase for we really have a number of closely related phases of one great problem rather than a number of distinct problems.

There is the great international phase; there are the broad national phases in which we are interested and responsible, aside from connection with a particular industry; there are the phases which impose demands and opportunities upon us by virtue of our association in automotive industries. Each of these phases dovetails into the other, and each is absolutely essential to the success of the others and the success of the whole.

Underlying our whole war experience are tremendous principles of justice and equality and humanity, democracy and service. And under these principles, we have proved beyond argument the value and practical necessity of democracy and cooperation and teamwork as opposed to autocracy and selfishness. It is not unexpected, therefore, that for peace-time reconstruction and progress, the world should look to these tried principles and methods and philosophies.

The resources, courage and strength of this nation have long been estimated but in the last 2 yr. have been demonstrated and proved. We have been surprised ourselves at the natural and manufacturing resources of the United States. We have demonstrated that when forced by war, the United States can make itself practically independent of the rest of the world. We have been inspired by the way our national Congress has backed unheard of financial programs, almost without discussion. We have marvelled at the way the entire

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country has gone down into its financial pockets and subscribed and oversubscribed the most stupendous war loans. We have seen the night and day fights made by manufacturers and engineers and workmen in the determination to rush supplies and equipment to insure success for those at the front.

We are proud as ever nation was of "Yank" courage in every field and every minute. We are proud of nearly every citizen, for nearly every citizen has had his courage tested; the President of this United States, as he assumed chief responsibility for entering into war; the congressmen as they braced themselves to see this thing through at any cost or sacrifice; the manufacturer or engineer or doctor or educator, as he buckled on the uniform and with heart pangs but unfaltering courage turned from home to enter special service which might carry the supreme sacrifice; the American "doughboy," as millions strong he stepped forward in answer to the call and went; the father and mother and sweetheart who remained behind and toiled and toiled and prayed.

The "strength" of the nation has been established three-fold—its natural strength, its physical strength and its moral strength. Victory we admit must come to such three-fold strength, if we admit any direction in civilization and history upward and onward. We stand, in other words, a nation today as strong as any in the world, materially, physically, morally. It is not worth while to argue whether we are the strongest. In this strength there is involved a definite, concrete, inevitable responsibility and problem. That responsibility is to see to it that this strength is devoted to the advancement and happiness and uplift of this nation, individually and collectively, and therefore and thereby to the advancement and happiness and uplift of the world. It is for us especially, as automotive manufacturers, engineers and educators to ponder this responsibility just now in these times of reconstruction and reorganization and readjustment. For in these United States we are recognized today as controlling and directing a considerable part of this strength, naturally, physically and morally. It is our responsibility to guard individually and collectively against national failure in strength such as has come to Germany; national failure which will inevitably result in any nation and to any people when loving kindness and charity are prostituted before greed and lust, when natural and physical strength are exalted for selfish and degraded ends, when might is crowned right.

What the War Has Taught Us

We have learned in this war to appraise the dollar and the million. They are at best only a means to an end. The world knows as never before, of the worthlessness, if not the positive danger, in a dollar or a million improperly directed. Of what but negative value is the million devoted to selfishness or oppression; of what but negative value is the factory which develops its machines and its material output and its speculative stockholders and neglects its cooperative personnel; of what significance is the university or even the church, when prostituted as in Germany, to greed and selfishness and autocracy. In the memorable words of Hon. Job E. Hedges, at our recent New York meeting:

> What does it amount to if we produce another railroad, a finer type of bridge, or a better machine, if it but leads to a conspiracy for the control of the earth? What does efficiency amount to if that, after all, is the end; if it places in the hands of the privileged few the control of the masses who are to be trained to service very much as the ox or the horse is trained?"

This war has demonstrated, as no other experience could, the relative value of material things. Compared with a principle, a right, an ideal, with happiness, with uplift, with character, the dollar or the million has absolutely no measurable value. As a means toward these ends only does it obtain from society a value rating. And it would be hard today to find anyone who does not justify all the money and property and even blood spent in preserving and defending the half dozen principles and ideals upon which our participation in this war is acknowledged to have been based.

Each one of us who has been associated in active war work, in uniform or out, has learned how little money and property really amount to compared to fundamentals. What untold sums, for example, each of us would have given at certain crises, for an improved design, for a direct decision, for a week's time, for the return of a single soldier lost overseas.

We have not only a full understanding of the dollar and the million; we have today an understanding of "the other fellow" in our team, and he has, in most cases, been sizing us up as well. War is a great leveler, and today, as a nation, we understand one another better than perhaps any nation ever has before. Two million men have not been molded into a great army without wide acquaintanceship and understanding and intermingling of all classes, colors, sects and convictions. The westerner has come to understand the easterner and has been interested in his viewpoint. The machinist has associated with the salesman and fought side by side with him.

Officers and men have been drawn together by common duties, common dangers and common ideals. The employer and employe have come to know one another and have discovered that in many ways, and surely in fundamental particulars, they are much the same sort of fellows after all. The laborer and the workmen have been lined up alongside the capitalist and the bridging of the gap has demonstrated that fundamentally their aims and services and rights are the same. And with this knowledge there arises at once a responsibility and a problem which is inevitable for manufacturer, engineer and educator. The theory that all men are created free and equal is more basic in this country than ever before, and the fundamental theory that each citizen is entitled to "life, liberty and the pursuit of happiness" has been interpreted to include an equal opportunity for labor and a fair share in the results of labor. The average citizen in this nation might be expected to demand:

(1) The opportunity to work hard and energetically and cooperatively
(2) Sufficient wage or salary or income to pay for reasonable expenses and pleasures for himself and family and to lay aside something against a rainy day or old age
(3) Reasonable working conditions
(4) Reasonable hours to enable some time for work, study or leisure at home and for pleasure
(5) Reasonable chances of progress

Even in the army our young manhood have grown to think of officers and men upon more or less equal ground; they have both had time off for recreation and personal pursuits; they have both had reasonable working conditions, when this was possible, even under the exigencies of war; they have both become used to having the other fellow interested in him and his success. Many conditions, on the other hand, have simply been tolerated by these young men because they had to tolerate them, and

they have come back into civilian life with a confidence and a determination that certain conditions should not and will not be tolerated. It will be well for us, as manufacturers, engineers and educators, to meet this situation squarely, to discard all academic argument and feigned complexity and treat the matter of capital and labor and employment and citizenry upon the ground of simple equality and justice and fair play and cooperation.

It seems pretty generally admitted that labor will demand and should have its fair share in profits, responsibility and management. A number of valuable and timely discussions have been had and there is little doubt that the basic fundamentals necessary for proper cooperation have been pretty well outlined.

Automotive Industries has ably said, editorially:

> Cooperation is very largely psychological, whether it is between the employer and the employe or between persons occupying approximately the same business plane. You have two parties in cooperation, and if the cooperation is to be real, then it must result from the united effort of both parties.
>
> It cannot come if the plan is worked out by one of the parties and thrust on the other. This is not cooperation but rather coercion. The plan must be one of mutual evolution.
>
> In the labor problem many of the so-called cooperative plans have failed because they were evolved entirely by the employer. He worked out the entire plan, but put it up to the workers as his plan. They had no voice in it. They were merely asked to accept it.
>
> It did not get a favorable reception from the workers because it was thrust upon them more or less as a charity measure so far as any additional wages were concerned. As such it flavored too strongly of paternalism. It was not cooperation in the sense of two parties working to do a job better and for the improvement of the two parties on an equal basis.

Again, Mr. Harry Tipper has, in one of his analyses, said:

> It is not enough to pay high wages, and it is not enough to invite the worker to share in the decisions affecting his condition. Responsibility must be given, and the reward for that responsibility must also be included. The most successful operations of this kind have included both, and it is significant that the comment of the workers in these individual organizations has continually opened up with the statement that this organization was "on the square" or "on the level" or some similar expression designating the removal of suspicion.
>
> The most difficult thing to establish and the one thing most necessary in the development of an orderly industrial organization is the demonstration among the workers of the fairness of the company's policy and operations, and it constitutes in the minds of the workers the most important basis for satisfaction, as evidenced by the fact that this point is always brought out by the workers as the first and most important accomplishment.

Dr. Charles P. Steinmetz, in a recent address, has clearly pointed out the basic contention.

> "At present," he says, "industrial production requires capital and labor. Both are necessary. Labor unrest is a demand for a share of the profits of industry and a share in the management of industry. This is the final foundation of all our social unrest. Since they are both necessary it is right that they both demand a right in the share of the profits and management of industry."

It would be unfortunate here to project any particular solution, but it would likewise be unfortunate not to recognize the fact that, based upon the right premises, any one of half a dozen solutions will be just and fair and progressive and satisfactory. Certain it is, however, that from this date forward, this country will not tolerate autocracy and oppression based upon wealth any more than it will autocracy and oppression based upon birth. Certain it is, also, that the doctrine of shorter hours, poorer work, less responsibility but *more pay* will not lead to the right sort of participation or cooperation or teamwork or success. Such doctrine or organizations espousing such doctrine cannot and should not survive.

The Most Important Lesson

And all this brings us to the most far-reaching and most fascinating lesson of the last 2 yr., the meaning and practicability of cooperation and teamwork. In this important matter, we, like perhaps all the other of the Allied nations, were far behind the Germans. And if this great lesson of teamwork may be properly put into pratical operation, we shall individually and collectively take giant strides forward. After our war experience, it would be criminal even to argue the advisability of teamwork and the closest practical cooperation. The day is past when either the manufacturer or engineer or educator can fence himself off and separate himself from the success or failure or responsibilities of the other two. And by success, we have in mind larger things than money alone. If any one fact has been driven home more conclusively by this war than another, it is the fact of the tremendous dependency of modern life, both in peace and war, upon technical and scientific equipment and theory and men. And the proper furnishing and development of technical and scientific equipment and theory and men is a job which takes manufacturer and engineer and educator pulling as one single team. The day is past when the automotive engineer can passively work up designs and amuse himself with mathematical gymnastics and after making technical recommendations, leave critical decisions to the management or the sales department. The day is passed when the automotive engineer can wink with an irresponsible eye at the technical mistakes involved in production, inspection, sales, service or even the advertising department. Some of our most vital delays and mistakes in this war have been due to just this matter of division of authority and responsibility and the resulting failure in teamwork, if not to say actual conflict of interests. The engineer here tonight who simply sits back and says he is not responsible for the labor situation or the production troubles at his plant or the ridiculous advertising put out by his firm or for results of this paper because it has no mathematics or diagrams in it, is just the fellow you want to talk with in a kindly way and help to see his real position and opportunity on this great automotive team. The day is passed when the management or the sales department can afford to proceed without the active approval of the engineer. The day is passed when the educator can claim exemption from commercial interests and service and devote himself to the past and its dusty designs and theories to the exclusion of present-day practical requirements and research and progress.

Four simple axioms have made success for the team of a certain great football coach as follows:

(1) Eleven men in every play
(2) Know every rule and signal
(3) Know where every other man is in every play
(4) Fight hard but fairly every minute

And practically the same rules will make for the success of a nation, which, after all, is in war times and peace times simply one great team. Eleven men in every play means everyone in the team. That means the manufacturer, the engineer, the educator, the statesman, the capitalist, the laboring man. It implies understanding and cooperation. As it entered the war, this nation, as we all know, was not a team; it was far from a smooth running machine. It was rather a combination of stars, each one more or less intolerant, if not jealous, of the other and each one playing largely for himself and the grand stand. And in national or industrial endeavor as in football, it goes without argument that such a combination might be beaten by a real team of much less individual ability. What cost us heavily in money and took up a heartrending amount of time in this war was the organization and training of just this sort of a team. It took us, as you all know, a long time to gather together the members of the team, it took us longer to teach them the simplest signals of war and the simplest principles of real teamwork; we had some sad experiences in our practice games and in our secret practice behind the closed gates. Even some of our captains, in uniform and out, had trouble in the direction of the team and especially in giving definite, clean cut, understandable signals and then carrying the play through on exactly that signal without conference or argument or change. Some members spent so much time right out on the field during the game in criticising the other members of their team, that when the whistle was blown on Nov. 11, 1918, they had mighty little to show for their part except criticism.

The lesson learned was first, the real meaning of cooperation and teamwork as a nation, and second, the practicability of this. We learned further the absolute necessity of this cooperation and teamwork in war times and its equal necessity in peace. The problem is to make sure of what our peace-time jobs and duties and opportunities are and then to devote ourselves to these.

The Opportunity of the Industry

As members of the automotive industry, our opportunities are perhaps the greatest of any industry in this country. The importance and far-reaching necessity of our products is established; the value of the product in the advancement of civilization is no longer a matter of speculation or doubt. No other civil arm of the nation is more far-reaching in peace times, no other arm should be more instantly available in time of emergency.

Recognizing the importance of this industry and its future stability and permanence, it is high time that automotive manufacturers gave consideration to the permanent and stable establishment of their business and their product. The day of the automobile and the motor truck "game" is or should be past. The automotive operating public is less interested in fads and freaks today than ever before. The soundness of a permanent and stable establishment, both as to methods of production and product, has been completely proved by a number of the more prominent, if not to say most successful, manufacturers. In the opinion of an increasingly larger proportion of the public, the complete yearly change in model is not necessary or desirable, and in its last analysis indicates shortcoming in design and shortsighted engineering and business policy, together with unnecessary cost. From another angle, there is little reason at this day for the general rating given automotive industries as reflected in their stocks. It is a matter for us all to consider that "motor stocks" are regarded today in general as not far removed from the speculative class of oil and mining stocks. It is not often that automotive stocks are recommended by conservative bankers or financial experts as an "investment." A few notable exceptions demonstrate that with the establishment of a sound productive and engineering and model policy, the automobile and motor-truck business can now take its place beside that of industries producing railroad equipment, electrical machinery and other stable necessities.

Advertising and sales engineering need the attention of many manufacturers and boards of directors. Extravagance and error, if not to say misleading propaganda, in these most important departments work out to the injury of the individual and the industry as a whole. They are boomerangs whose return cannot be dodged. In the first place, the American public has become pretty well schooled in automotive fundamentals and cannot be sold on exaggeration or "salesman's talk"; second, the large proportion of manufacturers today have products which make a market and insure a sale for themselves through meritorious design and performance. Every manufacturer will do well to insist upon cooperative responsibility by the engineering division in technical or semi-technical literature published. This society has at great expense and professional effort, standardized tests both for engine and car performance, and great benefit will result to manufacturer and engineer and public when these standard tests are used for comparative results. Such tests are thoroughly reliable and comparative and when supplemented by actual road operation and riding in a car or truck, afford practically complete performance data. With the automobile and truck operating public well educated as they are, and with the purchase, operation and maintenance of the equipment made by or with the advice of technical men, the question is constructively raised, whether right now automotive manufacturers cannot profitably publish authoritative performance curves for their product as the manufacturers of electrical equipment have done for years. The day should have passed when this society or the National Automobile Chamber of Commerce will allow the publication for our own and public consumption of technical tests not properly supervised and technically authenticated of stock performances which cannot possibly be duplicated by any stock car purchased by the buyer for the stock price; of advertisements and claims which are by their omissions or inferences or make-up, clearly misleading. Many manufacturers have realized the great advantage to be had by the infusion of a limited amount of conservative technical blood into the advertising and sales departments, and this experiment has proved to be excellent for all parties in the bargain. The composite of individual reputations in the automotive field makes up the general reputation of the industry. The success or failure of the individual makes for the success or failure of the industry as a whole.

Internally the manufacturer has the problem of the training and education of his employes to the mutual advantage of both and, looking toward a diminution in labor turnover, the development of a certain number of supervisors or executives from the ranks and in general an improved esprit de corps. In the general scheme of cooperation, training and education to a limited extent are both desirable and profitable for employe and employer. This problem is as large as it is important. Many manufacturers have already made great progress along this line and its fair discussion would require one or several complete papers. Suffice it here to suggest

that the training and education of employes is not a one-man job, but requires again a team of three, the educator, the manufacturing specialist and the sociologist. An educational team made up of only one of these is like a football team composed of nothing but backfield men, and several of the failures recorded in automotive educational work may be ascribed directly to this cause.

Many manufacturers and engineers even in this day fail to appreciate the importance of design, manufacturing and organization, of service requirements and opportunities. The automotive industry is today elevated to a public-service industry. The public depend upon us for a part at least in their greatest and best pleasures; they depend upon us for increasingly more service which makes modern business and business transportation possible. And there is absolutely nothing that gives so large a return upon the investment as reasonable service, at a reasonable charge to an owner when he is figuratively or actually "in a hole."

Many of us confuse service with "self-service" and reason that a man should be satisfied with the same sort of service for his automobile or motor truck that satisfies him for his quick lunch. And just there is the critical mistake. For after a man has made an initial investment of from $1,000 to $5,000 in an automobile or motor truck, the surest way to lose that customer and one's own reputation is to hand him out in the way of service what he gets as part of the overhead with a 10-cent, 10-min. lunch.

On the other hand, the practicability of reasonable service at reasonable charge has been more successfully demonstrated. It is not only possible but profitable for every manufacturer to provide service over every territory in which he means to distribute. And through the service department there comes a real opportunity for the manufacturer to benefit not only himself but his engineer and the public.

The Part of the University

The university and the educator are not without special responsibilities upon the cooperative automotive team and special opportunities for practical service. Through regularly established curricula they should offer to the prospective automotive engineer, to the prospective operator or owner of automotive apparatus and to the public, such general, design and laboratory courses as are required for a foundation on which to base an engineering or automotive career. The matter of technical automobile engineeering instruction has passed the experimental stage. Since the establishment in 1914, in the college of engineering of the University of Michigan, of the first automobile engineering curriculum this work has steadily increased in importance and in number of students to an enrollment of some 200 per year just previous to the war. The enrollment for next year promises to reach an even greater figure. Graduates from these courses have become known to many of the Society's membership, as they entered engineering, technical sales, experimental or production fields. Their records and successes, as shown by advancement and increased responsibility, are the sort of approval the University appreciates. The University will each year be willing to recommend for your employment those young men who have been graduated from the automobile engineering course, and in addition have displayed that right attitude and initiative and reliability which are so essential to success. They will not be automobile engineers, they will not have that experience and judgment which comes to the engineer only through years in the field of production, but they will have a fundamental engineering education and a limited amount of specialized automobile work which should make them valuable in your organization.

In the field of research and general developmental work, the university, with the Government, should cooperate, if not lead. The Government, through the Bureau of Standards, is taking active steps toward far-reaching research along certain lines, and universities throughout the country have undertaken or are to undertake work along general research lines for which they are specially equipped. The University of Michigan, through its Board of Regents, has this month provided for the establishment of the first distinctively automotive laboratory for testing and research. A special temporary building, 60 by 180 ft., has been devoted to this work, and a liberal appropriation made for its equipment with the most complete apparatus. This laboratory will make possible not only the immediate expansion of the work in the regular instructional courses but in addition the establishment of research and development work under the liberal rules of the Board of Regents covering cooperative service for inventors, engineers, manufacturers and the public. With the expansion of the laboratories opportunity will be afforded for a certain amount of continuous directed investigation through the establishment of research fellowships in which it is hoped this society will be actively interested.

The university has a distinct function as a clearing house for the industry and the public in the matter of testing out and reporting upon new equipment, accessories, units and complete vehicles. The manufacturer, the engineer, the investor and even the operating public will, before taking definite action in any case, desire personal observation and trials. In the majority of cases they have neither the time nor the inclination, and certainly not the patience, to make proper preliminary investigations. The service which the university can render to the industry and the public with reference to such units as carbureters, governors, engines, transmissions, differentials and the like, has already been amply demonstrated. The university certainly can render special service to the public and the State by performing tests upon the various species of fuel savers, carbon removers, power boosters, if not to say "mile and smile makers."

In cooperation with manufacturers and their engineers, the university has a duty and an opportunity for definite service in running authoritative performance tests upon stock automobiles, motor trucks, etc. The publication of such results would be of large cooperative value both for the automotive engineer, the prospective purchaser or operator and the public in general. Michigan has already undertaken this work through its advance research squads and by continuance over a number of semesters should provide valuable data. In all cases, several cars are obtained from owners in the State and are put in good stock condition before the tests with the assistance of specialists in the effort to get first-class stock performance. In a further attempt to obtain reults which will be entirely fair to the car being tested, the factory or local representative is permitted to furnish a demonstration car in best stock condition. The composite result of the tests in the several cases should be valuable.

The university, in cooperation with the industry, may serve in furthering proper legislation relating to automotive development and control, first, by the education and instruction of its students; second, by preparing and suggesting legislation to representatives and senators and

by advising them thereon, and third, by public instruction and lectures. In this connection there seems to be, right now, a crying need for definite legislation, or reform of legislation, in the State as follows:

(1) *Licensing of drivers* In the interest of the driving and walking public as well as the manufacturer, persons should be required to be of reasonable age and to demonstrate by definite examination reasonable driving ability and control before being allowed to operate an automobile upon the roads. I have marvelled for years at the short-sightedness of a public which would allow anyone who knew how to step on a starter button, or who had accumulated \$500 to \$5,000 in cash, to proceed upon the highways and into traffic with a machine as swift as the express train and as powerful and unruly, until mastered, as a forty-horse team. I have marvelled, in one case, at the boast of an otherwise sane lawyer that his little girl of five was the youngest automobile driver in his town; in another case, at the proud farmer who told of getting into his new car in the factory yard and "fetchin' her home" without ever having had a word of explanation or "studied the critter 1 min". And, considering a fairly large proportion of drivers, it is no wonder that accidents are as numerous as they are, and that automobiles and motor trucks fail to stand the maltreatment they receive.

(2) *Rating, specifications and performance curves* In the interests of all concerned, uniform methods of rating, of presentation of specifications and of furnishing performance curves for both engine and car should be regulated and required by proper legislation.

(3) *Prohibition of deception, misrepresentation, false advertising and false pretenses* The Michigan State Legislature has just passed a bill "prohibiting the use of deception, misrepresentation, false advertising and false pretenses in the procurement of employes to work at any labor, employment or industry in this State," and it will be only one step further in the right direction when the same prohibition is applied along other lines. Such legislation, with reference to automotive products, would be in the interest of all reliable manufacturers, distributors and the public.

In cooperation with the Government, the manufacturer, the engineer and the public, the university must assume its share in the matter of good roads development and highways transport. It is most gratifying to see the State of Michigan in the vanguard of States in the matter of good roads development and the \$50,000,000 voted by our last legislature will, if properly directed and expended, mean great things to the automotive industry, to the farmer, to the city man and to the State at large. Three men are specially qualified to advise and assist the public and the State in the proper distribution and expenditure of these good roads funds and to advise as to specifications and design for the roads themselves as well as to the regulation and control of traffic and of operating equipment. These three men are the automotive manufacturer, the automotive engineer and the automotive educator. Already, broad and patriotic cooperation has been offered by a number of manufacturers and automotive engineers. The University is prepared to assume its share in this important work and has made plans for cooperating in the following:

(1) The establishment of a limited amount of specialized highways and motor transport instruction under the combined direction of the civil and automobile engineering staffs
(2) The institution of research and developmental and testing work along lines of
  (a) The roadbed
  (b) The operating equipment
(3) Cooperation with various local or State committees or commissions in the determination of the most advantageous procedure in the expenditure of good roads funds

This is an inspiring period. After the greatest military and moral victory in history, the world has the greatest opportunity in history for peace-time victory and advance. The United States is most fortunate of nations in her opportunity for immediate constructive progress, and among industries the automotive industry is most fortunate in its opportunity for service which will definitely assist in the progress which is bound to come.

An attempt has been made in this paper to emphasize the value and necessity in peace-time success, as well as in war, of ideals and principles, of money and strength as a means and not an end, of active, sympathetic cooperation and teamwork. A further attempt has been made by definite analysis of two or three simple opportunities to suggest even a greater service which could and should be performed for the benefit of the industry, the average citizen and the State by a properly organized, broad-visioned, cooperative automotive team composed of manufacturers, engineers and educators.

NEW YORK TO SPEND OVER \$16,000,000 ON HIGHWAYS

An expenditure of over \$16,000,000 by New York State for new roads this year is planned. It is expected that in 1920 the State will receive a sum estimated to be over \$8,000,000 from the Automobile Bureau. This sum, which compares with the sum of \$2,700,000 received from the same source in 1918, will be expended for the maintenance and repair of highways. This work marks the inauguration of a campaign for roads with a hard, smooth surface which can be kept open for traffic at all seasons of the year regardless of weather conditions. When this program of road development is finished, it is planned to have a state-wide system of highways connecting not only the principal cities but practically every important town.

The money to be spent by the State for highway purposes is received from the following sources:

Direct appropriation for maintenance and repair	\$5,500,000
From automobile fees	3,000,000
State aid to towns and counties	2,180,000
Federal aid	575,000
State appropriation to equal this	575,000
For relief of contractors to enable them to finish pre-war contracts	3,500,000
New bridges	900,000
Total	\$16,230,000

In addition the various towns and counties will spend over \$5,000,000 for the same purpose.

An Investigation of Airplane Fuels[1]

By E. W. Dean[2] (*Member*) and Clarence Netzen[3] (*Non-Member*)

THE chemical section of the Bureau of Mines' petroleum division began its preparations for war work some little time before the United States actually entered the war, but in the first few months no attempt was made to concentrate on any specific investigation. Research requirements in the field of petroleum chemistry were not outlined as definitely as those of some other fields of chemical activity, and it was therefore deemed advisable to avoid false starts and give attention to fundamental preparations of a general nature until such time as the relative importance of the problems could be estimated. The preliminary work of the first months need not be described in the present connection, but it may be stated that practically all of it was found later to be of utmost importance.

Shortly after the proposed airplane program of the United States was announced, W. F. Rittman and C. H. Beal of the Bureau's petroleum division conferred with Major Souther of the aviation section of the Signal Corps and arranged that the Bureau of Mines should undertake to study the problem of aviation engine fuel. About Aug. 1, 1917, Chester Naramore, chief petroleum technologist of the Bureau, assigned the active work of the investigation to us.

Fuels for Training Planes

One of the first activities of the aviation section of the Signal Corps was the organization and operation of schools and fields for the training of aviators and it seemed advisable, therefore, to investigate the fuel needs of the types of engine used in training planes. Conferences with the Signal Corps officials in Washington indicated that this problem was one of many which had of necessity been left for solution to the engineers of various fields. The Bureau of Mines attempted, therefore, to ascertain as soon as possible whether or not the selection of a proper grade of fuel would materially help the training fields in getting maximum service from the limited number of planes available at the time. Mr. Netzen proceeded immediately to Langley Field[4] to supervise some comparative tests on the behavior of several grades of commercial gasoline in training plane engines, and Mr. Dean visited and conferred with a number of men actually in touch with the operation of aviation engines.

The grades of gasoline obtainable in the market[5] and used as engine fuel at this time could be divided into three classes, which for purposes of ready reference were given characteristic names by the Bureau at the time the Langley Field tests were begun.

(1) *Engine gasoline* This grade was generally used throughout the country, and although subject to variation through a considerable range of physical and chemical properties was understood to include all fuel having a dry-point of 374 deg. fahr. (190 deg. cent.) or above.

(2) *Grade X gasoline* This fuel was produced commercially for various purposes and was understood to represent products having dry-points between the limits of 320 deg. fahr. (160 deg. cent.) and 374 deg. fahr. (190 deg. cent.). This class included the gasoline generally exported, the so-called "high test" gasoline of the Middle West and of certain other districts, and the 68 to 70 deg. grade marketed in the Pittsburgh district.

(3) *Grade H gasoline* This type of gasoline was at the time of the Langley Field tests marketed in the Pittsburgh district as 73 to 74 deg. gasoline and was produced for special purposes in some other regions. During the gasoline shortage of the summer and early fall of 1918 it was withdrawn from the market and now seems to be definitely discontinued. For present purposes this grade was understood to include products of dry-point lower than 320 deg. fahr. (160 deg. cent.).

For the Langley Field tests arrangements were made with the Philadelphia refinery of the Atlantic Refining Co. to ship lots of Grade X and H gasoline to the field. Engine gasoline was purchased in the local Virginia market. After careful laboratory analysis of the samples, flying tests were made on the Langley Field Speedway, using two types of Curtiss plane equipped with 100 and 200 hp. engines respectively. Equally satisfactory results were obtained with each of the grades of gasoline. Similar indications had been obtained by all engineers, known by the Bureau, who have conducted dynamometer tests with automobile engines and the results were therefore accepted as reliable, even though they covered a limited range of operating conditions. It should be noted, however, that these conclusions do not cover either high-powered military airplane engines or the behavior of engines operated when not in a state of perfect mechanical adjustment.

Conferences with Engine Operators

While the Langley tests were in progress engineers of several organizations were visited and information obtained regarding their experience with different grades of gasoline. C. B. Kirkham and T. G. Kemble of the Curtiss Aeroplane & Motor Co., stated that they had compared the behavior of engines with different grades of gasoline and had found that when tests were made with properly designed and adjusted engines no appreciable difference could be detected as regards maximum power development. The Langley Field tests reported above confirmed this experience in a striking manner.

Capt. H. W. Flickinger of Chanute Field, Rantoul, Ill., reported that he had made a study of his own gasoline problem and had arrived at a satisfactory solution. He had first used a brand of gasoline that was practically on the border line between Grade X and engine gasoline. Later he had been able to obtain a supply of a special brand that was equivalent to Grade H. He stated that with the latter type of gasoline he could keep engines in service for longer periods between overhauls.

Major Maxwell Kirby, officer in charge of flying, and Sergt. Ryan, chief mechanician at Wilbur Wright Field, Fairfield, Ohio, did not have any definite information to offer with regard to the comparative behavior of

[1]Published by permission of the Director of the Bureau of Mines.

[2]Petroleum chemist, Bureau of Mines Experiment Station, Pittsburgh, Pa.

[3]Petroleum technology section, Bureau of Mines.

[4]Experimental work at Langley Field was at this time under the supervision of Major G. R. Wadsworth, who cooperated heartily with the Bureau in providing facilities for the series of tests that were outlined.

[5]Information on this subject had been obtained through a survey of the gasoline situation made in the first three months after the declaration of war.

different types of fuel. They were using a Grade X product and were not fully satisfied, stating that it contained water and that gummy deposits occasionally formed around carbureter jets. The water undoubtedly got into the gasoline on account of leaks in the storage system and the formation of deposits was possibly due to its presence.[6]

J. Percival, chief mechanician at Hazelhurst Field, Mineola, N. Y., reported that he was not having any gasoline trouble except in some cases where water seemed to get into the fuel tanks of planes. The grade in use was specially prepared by a marketing company for use at the field and was found on analysis to be a relatively low end-point engine gasoline blended with an unusually large proportion of casinghead or natural gas gasoline.

The most interesting information obtained was that supplied by engineers connected with the Dayton-Wright Airplane Co., who although not actually manufacturing engines were operating some planes in service for experimental work. Satisfactory results were being obtained with a gasoline equivalent to Grade X, but trouble had been experienced in an attempt to use heavy engine gasoline. The engine, a six-cylinder high-compression Hall-Scott, developed a tremendous knock and showed a smoky exhaust. It was not attempted to ascertain whether or not the trouble could have been prevented by changes in engine adjustment as the phenomenon was so similar to the "kerosene knock" encountered by the Dayton engineers in other engine tests that it was accepted as such without question.

The results of the Langley Field tests and the general information collected indicated that the problem of fuel for training planes was not a difficult one. It appeared that engines operated with volatile fuel required less careful adjustment than was necessary for the heavier types of gasoline but that the engineers at the various fields were getting reasonably satisfactory results without the use of a specification system for the purchase of their supply of gasoline. The problem of major importance was the study of the effect of different types of fuel upon the performance of the more highly developed types of engines used in actual military operations.

Arrangements for Cooperative Work

Having ascertained the general nature of the investigation necessary to determine what type of fuel should be used by the aviation service, plans were made for the actual work involved. The petroleum division of the Bureau was well equipped to handle the phase of the problem which covered the obtaining of a wide range of fuels and studying their physical and chemical properties, but lacked men and equipment for testing the behavior of fuels under conditions obtaining in the operation of aviation engines. Two possible lines of action were suggested.

(1) Securing the necessary additional men and equipment for aviation engine testing
(2) Cooperating with organizations having testing facilities but lacking the Bureau's knowledge of the fuel situation

[6]Similar trouble was experienced at a later date by flyers of the A. E. F. and the solid material deposit was identified as aluminum hydroxide, probably formed by the action of water on the aluminum carbureter parts.

[7]Export airplane gasoline was a grade equivalent to Grade H. used in the Langley Field tests but defined by more rigidly drawn specifications and involving the limitation of both the lower and upper portions of its distillation range.

The first plan seemed both impracticable and undesirable; the second was apparently highly feasible. The Bureau, therefore, prepared to undertake cooperative work on any general problems that might seem important and in addition made arrangements for active cooperation with two organizations that were prepared to undertake engine testing. The cooperative work of the Bureau of Mines can, therefore, be listed under the following three heads:

(1) General cooperative work
(2) Bureau of Standards cooperative work
(3) Dayton cooperative work

The general cooperative work was varied in nature and embraced so many phases that a full account would be beyond the scope of the present report. A few of the problems undertaken may, however, be mentioned. W. E. Perdew and H. H. Hill, stationed in the Washington office of the Bureau, conferred with numerous men and organizations interested in airplane work. An important line of activity was the investigation of various proposals which were offered either as solutions or helps to solution of the problem of maximum airplane efficiency. Experience here was similar to that of practically all other Washington organizations. Of the numerous propositions received the majority were valueless and a small proportion showed promise of merit. It should be stated, however, that only rarely was there evidence of any motive except a sincere desire to be of service to the Government. The impractical suggestions were generally made by men whose ideas were not based upon an adequate knowledge of the problems they hoped to solve. Most of the time and energy devoted by the Bureau to this line of work was wasted, but it was thought best not to risk condemning any proposal without making certain that it lacked practical value. Of the really important activities in which the Bureau petroleum chemists took part the following are described:

In the summer of 1918 the President appointed an official specifications committee for petroleum products, on which the Bureau of Mines was actively represented by H. H. Hill. One of the first activities of this committee was the drafting of specifications for airplane gasoline, and although the grades adopted were based chiefly on needs stated by the A. E. F., the form of the specification and arrangements for obtaining material required were in a considerable degree the work of the Bureau of Mines. W. E. Perdew, who was sent abroad in July, 1918, collected information regarding the airplane fuel situation and enabled the Bureau to correlate its investigations with those of organizations on the other side. Incidentally he ascertained that the "fighting" gasoline specified after receipt of a cabled request from General Pershing was recommended by the French air service and that the British never were convinced of its superiority over the less volatile "export" grade. Experiments made by the Bureau of Standards later indicated a slight superiority of "export"[7] over "fighting" gasoline.

The Bureau of Mines cooperated with the Fuel Administration on several problems that pertained to airplane engine fuel. An estimate of the country's potential production of "fighting" gasoline was made and a report submitted showing that if necessary the demands of the A. E. F. for this grade could be met. Samples of gasoline from Borneo and Sumatra were subjected to special analysis at the request of the Fuel Administration and it was shown that they were very promising material for use in high-compression engines.

The Bureau of Mines was asked to assist the fuel and forage division of the Quartermaster Corps in inspecting shipments of aviation gasoline. A number of outgoing cargoes, representing 2,600,000 gal. of "export aviation" and 725,000 gal. of "fighting" gasoline, were inspected by C. R. Bopp and W. G. Hiatt of the Bureau. The Bureau's ability to render prompt and reliable service in this line was due to the possession of several portable gasoline testing sets, which were designed, constructed and assembled under the supervision of W. A. Jacobs of the Pittsburgh station. These sets proved particularly useful and were in such demand that it was difficult to keep any in stock at Pittsburgh. They were supplied to the various petroleum laboratories of the Bureau, and in addition two sets were sent abroad at the request of W. E. Perdew.

E. R. Hewitt, engineer of the International Motors Co., New York City, was induced to accept a consulting appointment with the Bureau and contributed some particularly valuable experimental evidence regarding the relative ignition temperatures of various fuel mixtures. Mr. Hewitt showed that such fuels as benzol and alcohol did not ignite until heated several hundred degrees fahrenheit hotter than the ignition temperature of paraffin hydrocarbons. The data he furnished were particularly useful in indicating the order of ease with which various fuel mixtures could be made to pre-ignite in engine cylinders.

In the first few months of war the Bureau of Standards developed and installed dynamometer equipment capable of testing engines under conditions identical with those existing in the air at altitudes up to 30,000 ft. This altitude chamber was used for a variety of tests and considerable attention was devoted to the problem of comparing engine fuels. Results of the work are to be published by the Bureau of Standards and in the present connection it is intended merely to indicate the nature of the cooperative assistance rendered by the Bureau of Mines. A comprehensive list was prepared of the fuels that should be tried and arrangements made for the procuring of necessary samples. The various lots of gasoline received by the Bureau of Standards were checked and inspected by W. E. Perdew, H. H. Hill and C. R. Bopp and analyzed in the Washington laboratory of the Bureau of Mines.

The Bureau of Mines also served as an intermediary in investigating and bringing to the attention of the Bureau of Standards several promising fuel mixtures suggested by various men and organizations. The Bureau of Standards also conducted some tests with engines equipped with high-compression pistons to supplement the investigation made by a cooperative arrangement between the Bureau of Mines and the Dayton research laboratory. A description of this work appears in a later connection.

The research organization maintained by the Dayton Metal Products Co. was found to be studying the relation between the nature of fuel and the maximum compression ratio[8] that could be maintained in an engine without interfering with smooth operation. In the course of experiments with the air-cooled engine used with the Delco light equipment, which is adapted for operating with kerosene, it was found that the use of compression ratios above a certain limiting value caused what was described as the "kerosene knock" or "pinking" if kerosene was used as fuel. An engine showing this undesirable phenomenon could be operated smoothly if the fuel were properly selected. Benzol-kerosene or even gasoline-kerosene mixtures were notably superior to kerosene, and certain chemicals, particularly alkyl iodides, had specific "anti-knocking" properties. This phenomenon had been studied intensively and important information obtained as to its nature and the methods of preventing it. It was believed that this knocking or pinking was the chief factor that limited the compression ratios of airplane engines to the maximum figures maintained in standard practice, these being of the order of 5.4 to 1. The work of the Dayton research laboratory had shown the necessary characteristics of fuels capable of standing higher compressions and meeting all the other necessary requirements for successful performance, and it seemed that this investigation could be applied with great advantage to the aviation fuel problem. It was arranged that the Bureau of Mines and the research division of the Dayton Metal Products Co. should cooperate in ascertaining what fuels capable of standing high compressions were most desirable and most practical and whether or not the indications resulting from tests with the small Delco engine were supported by experience with larger units. It was realized that this line of investigation offered a possibility of materially increasing the power of airplane engines at the expense of very slight increases in weight and with no important mechanical alteration except the substitution of high-compression pistons.

The results of both the earlier experiments of the Dayton research laboratory and the cooperative work with the Bureau of Mines are to be reported in detail in a series of papers now in process of preparation. The present paper does not attempt to present the detailed information that will be included in these strictly technical reports but in a general way reviews the most interesting features of the work.

The Dayton work may be divided under three heads:

(1) Preparation and obtaining of fuels
(2) Engine tests under various compressions
(3) Supplementary tests including flying tests and tests in the Bureau of Standards' altitude chamber

Preparation and Obtaining of Fuels

Preliminary experiments of the Dayton laboratory had shown that the chemical properties of the fuels were more important than the physical ones. Samples of gasoline were therefore obtained that were derived from different varieties of crude petroleum. Synthetic or cracked gasolines were obtained from companies operating several different cracking processes. Benzol was obtained and was used as such and in the form of various mixtures. Alcohol and alcohol mixtures were obtained and prepared. In addition an extensive research was devoted to the production of cyclohexane, otherwise named hexahydrobenzene or hexamethylene. The history of this investigation is interesting and as this product later proved of considerable importance on account of the work is given in brief.

In the course of the conferences previously mentioned we were frequently advised that the Germans were using

[8]The term compression ratio means the ratio between the volumes in an engine cylinder above the piston when the latter is respectively at lower and upper dead center. A figure in pounds per square inch is sometimes used instead of the ratio figure, this representing the pressure developed by compression when the engine is turned at a certain speed under definite conditions. Both the maximum horsepower and the thermal efficiency of an engine can be increased by increasing the compression ratio. The maximum desirable value for the latter is controlled by a number of factors, mechanical as well as chemical.

cyclohexane as airplane engine fuel. These statements were somewhat disconcerting, as it was realized that the obtaining of cyclohexane in sufficient quantity for actual tests involved considerable difficulty. In the early stages of the Dayton cooperation Mr. Dean had an opportunity to review the original and sole evidence upon which was based the rumor that the German aviation service had been using cyclohexane. This evidence was in the form of a report from a French laboratory of the analysis of some gasoline taken from a captured German airplane. It was found that the figures contained in this report had been misinterpreted and that they indicated the absence rather than the presence of cyclohexane in the German gasoline. In this connection it may be mentioned that there seems to be no evidence that the German airplanes operated with anything but a good grade petroleum gasoline at any time during the entire war.

Upon his return to Dayton with the news that the cyclohexane problem was solved, Mr. Dean was informed that a review of the properties of this hydrocarbon indicated that it might be exactly the fuel that was required for high-compression engines. It was believed that in spite of their reputed efficiency the German engineers had "missed a bet." Experimental work on the hydrogenation of benzol was already in progress in the Dayton laboratories and developed shortly into an activity that proved highly interesting and important. The preparation of this fuel involved considerable difficulty and the earlier results were not very promising as regards ease of production, although the expected advantages of cyclohexane were demonstrated the first time it was tested in an engine. A detailed description of the investigation devoted to the hydrogenation of benzol is to appear in a future technical paper of the Bureau and for the present it may simply be stated that the initial production of a pint per week of 24-hr. days was subsequently increased to a maximum of 28 gal. per 24-hr. day. No evidence was obtained that even this quantity was the maximum that could be handled in a single hydrogenating unit and there was every reason to believe that successful large scale operation could be attained in a relatively short time.

The engine fuel actually tested after the first few engine runs was not pure cyclohexane but a mixture called "hecter," composed of from 70 to 80 per cent of cyclohexane and 20 to 30 per cent of benzol. Both cyclohexane and benzol have freezing points in the neighborhood of 41 deg. fahr. (5 deg. cent.), and if used pure are not suitable for airplane operating at temperatures ranging down considerably below zero, fahrenheit. The mixture of cyclohexane and benzol in the proportions used for hecter has, however, what is known as a eutectic point and freezes in the general neighborhood of 40 deg. fahr. below zero.

Engine Tests of Various Fuels

Through the courtesy of the engineers at McCook Field, the Bureau obtained the loan of a testing engine made by equipping one cylinder of a standard Liberty engine with a special crankcase, shaft and flywheel. A set of pistons was obtained which gave compression ratios ranging between 5.3 to 1 and 8.2 to 1. Pressures measured with an Edelman gage, with the engine turned at 400 r.p.m., varied from 113 to 185 lb. per sq. in. The use of dynamometer and machine-shop facilities were provided by J. H. Hunt, in charge of the research department of the Dayton Engineering Laboratories Co.

A considerable number of fuels were tested with his equipment and results obtained showing that gasoline composed of paraffin hydrocarbons had a marked tendency to knock at the 5.3 to 1 compression ratio, whereas hecter, benzol, alcohol and a special alcohol-benzol-gasoline mixture known as Taylor Fuel No. 4 showed only a slight tendency to knock under an 8.2 to 1 compression ratio.[9] Cracked gasolines and California gasolines were intermediate in resistance to knocking and were notably better in this respect than the paraffin base products which have in the past been highly esteemed as engine fuel. This superiority is attributed to the presence of unsaturated and cyclic hydrocarbons in the cracked distillates and to cyclic hydrocarbons in the California gasoline. Many of the fuels that resist knocking have undesirable properties that more than counter-balance this advantage and as a last analysis the most promising product was found to be hecter, with California gasoline or gasoline-benzol mixtures a second choice. Hecter was considerably superior in resistance to knocking and was used in subsequent tests to determine the advantages of equipping airplane engines with high-compression pistons. It was believed that additional tests with hecter would settle the proposition of using special fuels and super-compression ratios and that even if hecter was found to have specific unfavorable properties not heretofore detected it would still be possible to select or prepare fuels that were superior to gasoline derived from paraffin or intermediate base crude oil.

Supplementary Tests

A full set of twelve special pistons was obtained permitting the adjustment of a standard Liberty engine to 70 per cent of cyclohexane and 30 per cent of benzol in a DeHaviland Four plane and two trial flights made at McCook Field. The results were unfavorable, as trouble was experienced which was attributed to actual pre-ignition of the fuel, a phenomenon distinct from knocking or pinking.

The same pistons were transferred to the experimental field of the Dayton-Wright Airplane Co., and another Liberty engine tried in a DeHaviland plane. The hecter was changed slightly in composition so that it contained 70 per cent of cyclohexane and 30 per cent of benzol instead of being the original 80-20 formula. Benzol and benzol mixture were shown by E. R. Hewitt to have notably higher ignition temperatures than other hydrocarbons, and it was believed that the trouble experienced at McCook Field could be obviated in this way. The results of this series of flights were favorable, the engine operating smoothly and yielding the additional power that was to have been expected on account of its high compression ratio.

The high-compression pistons were then transferred to Wilbur Wright Field and a test flight made. Official permission to publish results of this test has not yet been received, but it may be said that they were even more favorable than the results of flights made at the Dayton-Wright Field. The engine operated satisfactorily and gave the increased power output that its high compression ratio warranted.

As a final test of the feasibility of using high compression ratios in engines employing hecter as fuel, the

[9]The experimentors were unable to operate the engine successfully with a piston giving an 8.2 to 1 ratio on account of mechanical difficulties. These it may or may not have been possible to obviate but the 7.7 to 1 ratio that did permit successful operation was considered high enough to serve as an upper limit for the series of tests.

pistons were installed in an engine in the altitude chamber of the Bureau of Standards. Here again the theoretical superiority in power output was substantiated and no difficulties were discovered incident to the use of the special fuel.

The tests just described were all that have been made up to date with actual aviation engines, and it is of course possible that extensive use of high-compression engines by ordinary operators would show up disadvantages that have not as yet been discovered. It appears, however, that with the single exception of the readily eliminated trouble with pre-ignition at McCook Field the tests with multi-cylinder engines are in complete agreement with those made with the single-cylinder type.

Summary

The present paper presents in brief form an account of one of the military activities of the Bureau of Mines. It is realized that the principal phase of the investigation was not carried to a conclusive finish, and the results of the tests with fuels suitable for high-compression engines are of value chiefly in that they indicate possibilities of power increase rather than a definite program toward this end. The signing of the armistice occurred at a time when plans were being formulated for the erection of a hydrogenating plant adequate for the production of hecter in sufficient quantity to permit its use under a wide enough variety of conditions to determine reliably all of its possible advantages and disadvantages.

The comparative data obtained with the single-cylinder Liberty engine indicate that by proper selection of fuel it is possible to employ considerably higher compression ratios than the maximum now considered practical for aviation engines. The establishment of this fact is of tremendous importance even if it proves that 7.2 to 1 ratio is too extreme and that hecter is not as practical or desirable as benzene-gasoline mixtures, petroleum gasoline containing cyclic hydrocarbons, or even alcohol mixtures.

TRANSCONTINENTAL TRUCK TRAIN TRIP

THE first military test of modern motor transport under strictly American conditions is now being conducted by the Motor Transport Corps. On July 7 the train of sixty-four motor vehicles, representing all the important types used by the A. E. F. in France, set out from Washington after Secretary of War Baker and other high officials of the War Department had taken part in a farewell ceremony. The main purpose of the long trip is to secure a performance test of the principal types of motorized Army equipment. At the same time the trip will be of great value both to the automobile industry and to the local communities through which the train is passing. It is believed that the practicability of long-distance motor postal and commercial transportation will be demonstrated and that the economic value of well-built transcontinental highways will be shown to the different States. There are, of course, many other reasons of a military and educational nature for making the trip, but the main interest of the members of the Society will naturally be in the performance data that will be obtained. Elaborate preparations have been made to secure complete information regarding road and weather conditions and to record the performance of each vehicle in the train.

The two Motor Transport Corps companies operate the convoy, but officers from the Motor Transport Corps, the Engineer Corps, Medical Corps, Field Artillery and the Air Service accompany the expedition. All these officers are observing the trip closely to use the experience in developing motor transport for their respective branches of the service. They have already proved of assistance in the operation of the expedition. The Engineer personnel and equipment have been useful in examining and strengthening the bridges along the route, many of which were not designed for heavy-duty motor trucks. The Air Service officers have been inspecting the country to assist in selecting landing fields for transcontinental airplane journeys and also to study weather conditions.

Sufficient equipment has been taken along so that the convoy is practically self-contained, the only exception to this being certain operating supplies such as gasoline and water which could not, of course, be carried in sufficient quantities for the entire trip. A stock of spare parts and repair materials is being taken. The blacksmith and machine shop vehicles with their power and hand tools will permit any ordinary shopwork to be carried out while enroute.

The transcontinental convoy is following the Lincoln Highway, although a number of detours have been found necessary because of road construction or maintenance work. It is expected that the trip will take about 2 months, although no effort is being made to make a speed record. The first 2 weeks of the trip have indicated that an average daily schedule of from 60 to 70 miles can be covered without difficulty. The distance covered, of course, varies with the road and weather conditions.

The schedule laid out provides for frequent stops at different cities and towns in order that the people along the road may have a chance to examine the vehicles and to be informed regarding the general purpose of the convoy. The interest already displayed indicates that the general public fully realizes the part played by motor vehicles in the World War.

The operating personnel consists of two truck companies to which the vehicles are apportioned. A list of these vehicles follows:

Type of Vehicle	Number
Light roadsters	1
Light touring cars	4
Heavy touring cars	1
Staff observation cars	2
Ambulances, heavy	4
Light delivery trucks	4
Trucks, 3/4 ton	2
Cargo trucks, 1½ ton[1]	9
Cargo trucks, 3 to 5 ton[1]	13
Cargo trucks, 3 to 5 ton[2]	4
Tank trucks	3
Kitchen trailers, four-wheel	2
Kitchen trailers, two-wheel	4
Motorcycles, with side car	4
Motorcycles, solos	2
Machine shop trucks	2
Blacksmith shop truck	1
Searchlight truck, light	1
10-ton trailer with pontoon	1
Total	64

[1]Two-wheel drive.
[2]Four-wheel drive.

Electric Vehicle Standardization

By HILDING LUBECK[1] (*Non-Member*) *Illustrated with* DRAWINGS

IN my 20 yr. connection with electric traction and storage batteries, I have followed with interest the development of the electric automobile. Some time before the outbreak of the war, I began a thorough investigation of the electric vehicle in the different European countries where they were built with a view to introducing them in Sweden, where, owing to the large sources of hydroelectric power, a great virgin field for them should exist. When I did not find anything in Europe that quite satisfied me, I extended my investigations to the United States. In consideration of the great success the electric car had met with in that country, I expected the American electric vehicle to be far in advance of the European ones. In some respects I found this to be the case, especially as regards the outward appearance of the electric passenger cars, but I do not consider that, even in that country, the development of electric cars has as yet arrived at the same settled stage as the gasoline cars, where the general arrangement can now be considered practically standardized, the various makes differing only in the detail designs and workmanship.

The electric car builders, on the contrary, are each still going very much his own way. As regards the arrangement of the battery, for instance, some are having it underslung, some on top of the frame, some in front underneath the hood, some divided between front and back, or in other manners. Also the sizes and the dimensions of the battery compartments vary with almost each make of car. Some are using one motor and others two or four. Some of these are series motors and some compound or shunt wound types. The arrangement of the motor or motors is very different and also the drive. Some are using a motor arrangement and drive somewhat similar to that of the gasoline cars, some are placing the motor near the rear axle and connected to it in one way or another, others have the motor built into the rear axle. Some have the motors near to and directly connected with the wheels in front, in the rear, or both, and still others have the motors built into the wheels in several different ways.

It seems to me that by now so many different methods have been tried it is about time some conclusions were reached from all the experience gained and at least the general design and arrangement of the principal parts of the electric car settled upon. Could this be done it would undoubtedly mean a tremendous advantage to the whole electric vehicle industry, and the electric car would be made a considerably more attractive proposition than at present. It is of more importance to standardize the electric car than the gasoline one because the former is dependent upon the batteries, charging and exchanging facilities, etc., and before the general design and arrangement of the principal parts have become more uniform there is little hope that battery service stations will be established to the extent necessary for the full realization of all the advantages of electric cars.

Although the electric passenger car has special qualifications to be made a car "de luxe," this line is not the most important one to my mind. It is where economy has to be considered in the first place that the electric car will find its great field, *i.e.*, for people with average means and for commercial and business purposes. The already extensive use and widespread popularity of the "electrics" for these purposes seem to indicate that there are great possibilities for this kind of vehicle. However, these possibilities can only be utilized to their full extent after a uniform system of battery exchange has been adopted and thus the service stations can be arranged on a uniform basis, as they are successively established in different places, spreading from the center of the cities to the suburbs, and ultimately forming a continuous net all over the country.

It is very evident that great difficulties will be met with in carrying through such uniformity and that this probably will take a long time. If those concerned would all work in one direction with this same aim in view, there is no doubt that the ultimate goal would finally be reached. Under existing conditions, however, when different builders turn out more and more cars with different sizes of batteries, arranged in different ways, the difficulties of extending the mileage of the electric car outside the limit of its own battery capacity will increase with every year and thus result in a growing handicap to their use, especially in the case of the passenger and light delivery cars.

There is no need at present to look on the electric car as a competitor to the gasoline type for long cross-country tours. It is better first to try to utilize all the possibilities of the former for town service, where it undoubtedly has its principal field, but even to do this one must be able to rely upon this type for tours of at least some 20 miles or thereabouts out of town, independent of weather and road conditions.

There is no reason why every taxicab and every omnibus in a city should not, at the present time, be electrically driven. Apart from other advantages, the banishment of a considerable number of smoke and odor producers from the big city thoroughfares, which could be brought about only by the electrification of these vehicles, must surely be highly advantageous. Such electrification would undoubtedly also be a splendid advertisement for the electric vehicle, because it would make people realize their advantages and importance, both for light and for heavy duties, as a means of city and suburban transportation, and the use of electric vehicles should increase very rapidly as a result. Then it becomes of the utmost importance for the success of the electric vehicle to avoid chaos, that such increase and development is carefully planned beforehand and directed along lines which lead to uniformity.

The question now is how the necessary charging facilities can best be arranged. The simplest way would probably be to develop the "boosting" system, but I do not believe that this alone will be enough to meet all the requirements. One cannot always expect people to wait long enough for a boost. It would therefore be more attractive if the exhausted batteries could be exchanged in a few minutes under a battery exchange system. An important reason in favor of the battery exchange system is that the batteries in this way can get better care,

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at the same time taking this work which is the only thing requiring any particular skill in connection with electric vehicle service entirely off the hands of the car owners or drivers.

Only through the battery exchange system can the charging of the batteries be done entirely in the off-peak period, which makes the electric vehicle a particularly attractive proposition from the central station view point, as a means of straightening out the load curve of the generating equipment. It therefore seems as if the battery exchange system must predominate, although the boosting system no doubt often can be of very considerable help in many instances.

The Sizes of Cars and Battery Compartments

A system of battery exchange cannot possibly be successfully operated without first carrying through a standardization of the batteries, with respect not only to the number of cells but also to the sizes and dimensions of the batteries and their location in the cars. This might seem a very difficult task, but considering the question more closely, I think it will be found far from impossible.

Taking into consideration the various sizes of cars and trucks now in use for different purposes, it is evident that it would be a great advantage for the battery exchange system to have the number of sizes reduced as much as possible. On the other hand, for trucks and particularly for the larger sizes, there is probably less need for very widespread charging facilities than for the small cars. The large electric trucks are rarely required to go farther than the capacity of their own batteries allows and are generally within reach of their own garages. Their routes are usually more regular, and it is therefore in most cases possible to arrange for a boost while the trucks are being loaded or unloaded.

To take care of all cases from about 1-ton capacity and upward, a series of four different sizes of trucks is now generally used of about 1, 2, 3½ and 5 tons capacity. The cars below 1 ton, the passenger and light delivery cars, vary considerably in size or load capacity. Dealing first with the trucks, it is evident that even if the manufacturers could agree upon the dimensions and arrangement of the batteries for these four sizes of trucks, it would still involve a very big organization, which would probably be very difficult to manage economically, to provide battery exchange possibilities for so many different sizes of trucks. The statistics show, however, that for heavy duty, more 2-ton capacity trucks are used than all the other sizes together. This experience seems worth heeding.

If we consider the larger trucks first and suppose that we start to standardize the 2-ton truck and limit the battery exchange possibilities to this size only, the problem would, of course, be greatly simplified. In all probability the extended battery exchange facilities, which could then be more easily provided, would cause an increased use of the 2-ton truck. In cases where great mileage was needed people would naturally try to use this truck. Soon the other truck sizes would be used only in exceptional cases and thus their number and importance would gradually decrease. It is evident that the advantages of the proposed standardization of the 2-ton truck would not only lie in the possibilities of increasing the mileage of this truck but also in the concentration on the construction of it, through which everybody would benefit.

It is but reasonable to expect that in special cases, where the standard truck could not be used, people would be prepared to pay somewhat more and be satisfied with something along the line of the present charging and battery exchange facilities. Most likely this would not mean a very serious handicap to the sale of the special trucks, as the present facilities probably would be satisfactory in most of such cases, and improvements undoubtedly would be made through a certain degree of standardization.

However, in spite of the indisputable advantages of the proposed standardization of the 2-ton truck from battery exchange and manufacturing points of view, one would probably be a bit too optimistic in expecting that this truck alone could advantageously replace all trucks now in use of say between 1 and 3 tons capacity. I have therefore considered the advisability of forming a group of trucks around the standard 2-ton truck, all using a single standard battery and the same battery exchange facilities. The smaller trucks belonging to this group could then have a somewhat higher speed and the larger ones a lower speed than the standard 2-ton. In this way one could probably make provision to build a range of trucks of 1½, 2 and 2½ tons capacity, all having the same size of battery.

For the larger sizes of truck one could, in a similar way, form a group around for instance the 5-ton truck, although, as previously mentioned, I do not think it necessary or wise to provide battery exchange facilities in the general service stations for these large trucks, as probably this could not be done without great complications.

Although standardization of the trucks would produce some noticeable advantages, I believe that the standardization of the small cars will be of even greater importance. I think the importance of the electric vehicle, within the field below 1-ton capacity, after the necessary standardization and uniformity have once been established, is but little realized at the present time. As the small cars unquestionably will require more widespread battery exchange facilities, it would be desirable to carry the standardization even further than would probably be needed in connection with the trucks. It would be ideal if, for all purposes requiring a capacity of less than 1-ton load, but one size of battery could be used, and preferably but one size of chassis. Such a battery and chassis would then form the basis of the "universal electric," which should find its use as the family car, the business and professional man's car, the taxicab and the light delivery car.

For delivery purposes, it would be possible with only very few modifications from standard, when necessary, to make the chassis somewhat larger than for the other purposes, still using the same size battery, as the delivery cars would probably as a rule require less speed. It might also be desirable to have a slow-speed car with a small chassis, which could compete with the single horse truck. I scarcely think, however, that it will be possible or practicable to carry the standardization as far as that, since there are too many different requirements to be taken care of within this range of capacities.

I propose, therefore, that all types and sizes of cars below 1-ton capacity should be grouped around two standard sizes of batteries. One of these battery units should be used for requirements below ½-ton capacity and the other from about ½ ton to something approaching the 1-ton capacity. I believe that the smaller of these battery units will ultimately prove to be of the most im-

portance, as this should be used for the universal electric.

Probably the time is not really ripe as yet for the universal electric. More frequent and widespread charging facilities must first be provided. Although the universal electric must today be looked upon as a future proposition, I consider this type of car of so great importance that the battery standardization should be planned with this in view. My present ambition is, through standardization of cars and trucks for all city and suburban transport requirements, to increase the use of the electrics. With such an increase the charging and battery exchange facilities will also increase, until the time has come to consider the universal electric.

At the present time I think one should concentrate upon a group of light car chassis around the standard large battery unit. From this it will be understood that my aim is to reduce the number of sizes of electric vehicles to only four standard types, two for light and two for heavy duty, although around each of these standard sizes could be formed a group of cars or trucks to widen their respective range of capacity and give the system enough flexibility to suit different requirements.

Having dealt now with the standardization of sizes of electric cars and trucks themselves, I wish to propose for consideration some different alternatives for the standardization of the battery sizes. The importance of such standardization is particularly great in connection with the light cars, inasmuch as these are more dependent upon a proper battery exchange system than any of the others. Next in importance is to decide on a standard battery for the 2-ton truck. Of less importance, as regards standardization, is the battery for the 5-ton truck.

For the present, leaving out the universal car, I propose as a first alternative a standard battery unit, say of 150-amp.-hr. capacity for the larger size of light cars, contained in one tray of suitable form. This unit might, in case of need, also be used in multiple to make up the batteries for other sizes of cars. Two such units connected in parallel would represent 300-amp.-hr. capacity, which would fill the requirements of the 2-ton truck, and three units, in multiple, producing 450-amp.-hr. capacity, would be suitable for the 5-ton truck. I should like to mention in passing that I do not propose that such units, connected in parallel, should be used regularly for the 2 and 5 ton trucks, as this would probably not promote a perfect functioning of the batteries, but only that the battery compartments should be dimensioned so that two or three battery units could, in case of emergency, be placed side by side in the space provided on the cars.

The batteries ordinarily used for the cars of larger size should consist of correspondingly larger cells contained in one tray only, but in case of need it would be possible through the above mentioned arrangement to provide for a battery exchange at any charging station supplied with the standard unit batteries. A second alternative is to make some corresponding batteries occupy the same floor space but contain cells of different heights according to the different capacities required. Through this arangement it would, for instance, be possible, in case of emergency, to run a big car home with some small car battery.

The interchange of the batteries between cars of different sizes might not be considered of sufficiently great importance to justify a perhaps less attractive appearance or unsuitable form of car, which might be unavoidable in case the previously proposed battery standardization should be adopted. In consequence one might propose, as a third alternative, that the batteries for the different sizes of cars have different dimensions, particularly chosen so as to give the cars good proportions and an attractive appearance.

Another arrangement of battery sizes and compartments makes use of two standard widths of battery compartments, 19 and 38 in., and one standard height, 16 in. Three lengths of compartment are used, 58, 70 and 85 in. The standard small battery unit measures 19 by 58 in. in plan, which is the space required for sixty Edison cells of the G-4 or A-3 type. The standard large battery unit measures 19 by 70 in. in plan and consists of sixty Edison cells of the G-6 or A-4 type.

The accompanying table gives the application of this arrangement to various types of vehicle:

ARRANGEMENT OF BATTERY SIZES AND COMPARTMENTS

Type of Vehicle	Width, in.	Length, in.	Edison Cell	Rating, amp.-hr.	Emergency Set
Small Car......	19	58	G-4 A-3	100 112	None
1-ton Truck....	38	58	A-6 G-9	225	Two small units in parallel
Passenger Car and Light Delivery Vehicle.	19	70	G-6 A-4	150	None
2-ton Truck....	38	70	A-8 G-11	300 275	Two large units in parallel
5-ton Truck....	38	85	A-12 G-16	450 400	Two large units in parallel

The preference of the one over the other of these alternatives will, of course, greatly depend upon how the batteries can be suitably arranged in the cars or trucks, a question which will be dealt with later.

In deciding on the dimensions of the battery compartments, the fact that the sizes of Edison or lead batteries of the same capacity vary materially must be taken into consideration. As the battery compartment, of course, must be made to take either kind of battery, the dimensions of the compartment have consequently to be chosen so as to allow for the difference in size, as this must not interfere with the uniformity of the battery exchange system.

Arranging, Charging and Exchange Facilities

As already mentioned, I am of the opinion that the net of service stations should grow from the center of the cities outward, until the different local nets meet and cover the whole country. In some cases it might, of course, be desirable to connect some local nets before they have actually grown large enough to meet, as, for instance, along some important main roads.

The realization of such a plan is, of course, too big an affair for one company only, and therefore cooperation must be secured. For instance, one firm could undertake to provide the necessary service stations in one town and these must be able to cooperate with the stations in a neighboring town. Or, if in the larger cities, when several firms provide service stations in different districts, all these stations must be arranged so as to be able to cooperate. In a city of say about half a million inhabitants there ought first to be erected one or more

service stations, located as centrally as possible, with great garage capacity and battery exchange facilities. Afterward come the stations in the outskirts of the city, preferably near the entrance to the city on the main roads. Next come the stations in the suburbs and eventually in some more distant places of special interest around the neighborhood.

The stations in the outskirts and outside a city would probably in most cases only need to have facilities for boosting and for exchange of the light car batteries. Perhaps it might be preferable to have separate stations for the light cars and for the trucks. This would not mean, of course, that either class of vehicle could not obtain a boost at any station.

The development of the battery exchange facilities I think should be planned in such a way that the small standard unit battery would be available in battery exchange stations all over the country. In the exchange stations in the cities and suburbs and eventually also at some stations along the main thoroughfares, the large unit should also be obtainable, and only in the city exchange stations or in the special exchange stations for trucks should the large-size batteries be available.

One or more emergency cars provided with battery exchange facilities should be attached to each station. These could, for instance, be called out on telephone order to exchange the exhausted battery in some car which was unable to reach the service station. The emergency cars could, of course, also be supplied with a gasoline engine charging set, so that they could go out and give a boost where it was needed. In some cases it might even be possible to arrange the charging set on the emergency car so that it consists of a motor-generator set which could be connected to the street or suburban trolley wire.

With the battery exchange system outlined, I propose that the electric vehicles, and particularly those for light duty, should preferably be sold without any battery and the electric power supplied on some battery service plan. In consideration of the great simplicity of electrical machinery and control, the acquisition cost of a standard electric car, if sold without a battery, should be very much lower than that of a gasoline car of the same size. This would, of course, help to make the electric car popular and readily saleable. The current could be paid for either on the basis of ampere-hours read on a meter in the car or on the basis of mileage as registered on an odometer.

To sell the electric vehicles without batteries will also be very much easier for the reason that the car owner need have none of the troubles connected with the batteries of the cars. It would not do to limit the car owner to one station only for exchange of his battery. The batteries must therefore belong to the stations which, of course, cooperate in one way or another with the battery manufacturers. As, however, the batteries cannot all be of the same age or quality and condition, it is evidently not possible to have a battery exchanged for another without further control and adjustment between stations of different ownership. The batteries, therefore, should be marked in suitable ways and from time to time exchanged between the different stations. To make this exchange more convenient, all the outside stations should be able to get batteries not belonging to them exchanged for their own or some reserve batteries at the central garage stations. The interchange of the batteries between the outside stations could also be suitably arranged through the central garage stations as an intermediary. These should be supplied for this purpose with one or more standard trucks, on which a great number of batteries could be loaded and transferred to the different outside stations.

One might, of course, remark that it would be very difficult to make such electric service stations pay for perhaps many years. Supposing, however, that the stations in the beginning were also used as garages for gasoline cars, and there seems to be no particular objection to that, it would probably be possible to make the stations pay very soon. Of course, it must be understood that the stations should be controlled by the electric car promoters, so that the gasoline cars could gradually be replaced by electric vehicles, as this became necessary. If the combination with the gasoline cars were not considered suitable, the space not required in the beginning for an electric garage could probably instead be let as storeroom or for other purposes.

It seems, therefore, that the establishment of electric service stations, if planned on a big scale along the lines proposed, would not only be of very great importance for the promotion of the electric car, but such garage stations, with all modern conveniences, could also in themselves be very good investments, especially as the stations, of course, should be connected with a business for the supply of tires and other reserve parts as well as with repair shops. However, a condition for success is standardization, and to be able to standardize the battery exchange facilities, it is necessary to go farther with the standardization of the electric car itself than even hitherto proposed.

Before leaving the question of battery exchange, I wish to add a few words about the speed of the electric vehicles. The slow speed is often claimed as a great handicap to the sale and use of the electric car. It must be admitted that this is a decided disadvantage when it concerns passenger and other light vehicles and to a certain degree also as regards trucks. In the latter case, however, I believe that the demand for high speed will in time become less insistent after people begin to realize the actual saving they can make by keeping within the limit of economic speed. Nobody would, for instance, today build a cargo steamer with the speed of an ocean greyhound.

With the electric passenger cars, on the other hand, it is different. An increase of their speed would without doubt be an advantage. It is, of course, a well-known fact that from the point of view of design there is practically no limit to the speed of the electric car. It is only because of the rapid increase in the current drawn from the battery when the speed is increased that one must at present keep down the speed to increase the mileage capacity of the car. As the battery exchange facilities increase, however, and you need no longer be afraid of running short of current, you can also begin to increase the speed of the electric vehicle.

Arrangement of the Battery on the Car

It is not sufficient that the battery compartments for a certain size of cars all have the same dimensions; the batteries must also be arranged in the same way on the cars to make it possible to use a uniform system for the exchange. Before a standardization of the battery dimensions can be accomplished the most suitable place for the battery must be found. This question will, of course, not be easy to solve. There is a natural tendency for different manufacturers to advocate some particular feature as a selling argument, and it will prob-

ably be difficult to get them to agree. The matter is of such great importance for the whole electric vehicle service, and therefore ought to be of such vital interest for the manufacturers, that a solution must be found, and the sooner this can be done the better. If it cannot be agreed upon, then one must try to force it through.

For a successful battery exchange system I consider it to be of utmost importance that the battery be arranged in one tray. For this reason all arrangements which have the battery divided between two or more locations on the car, cannot be used. It remains then to consider the underslung battery, the battery on top of frame and the battery in front underneath a hood, corresponding to the hood over the engine on the gasoline cars.

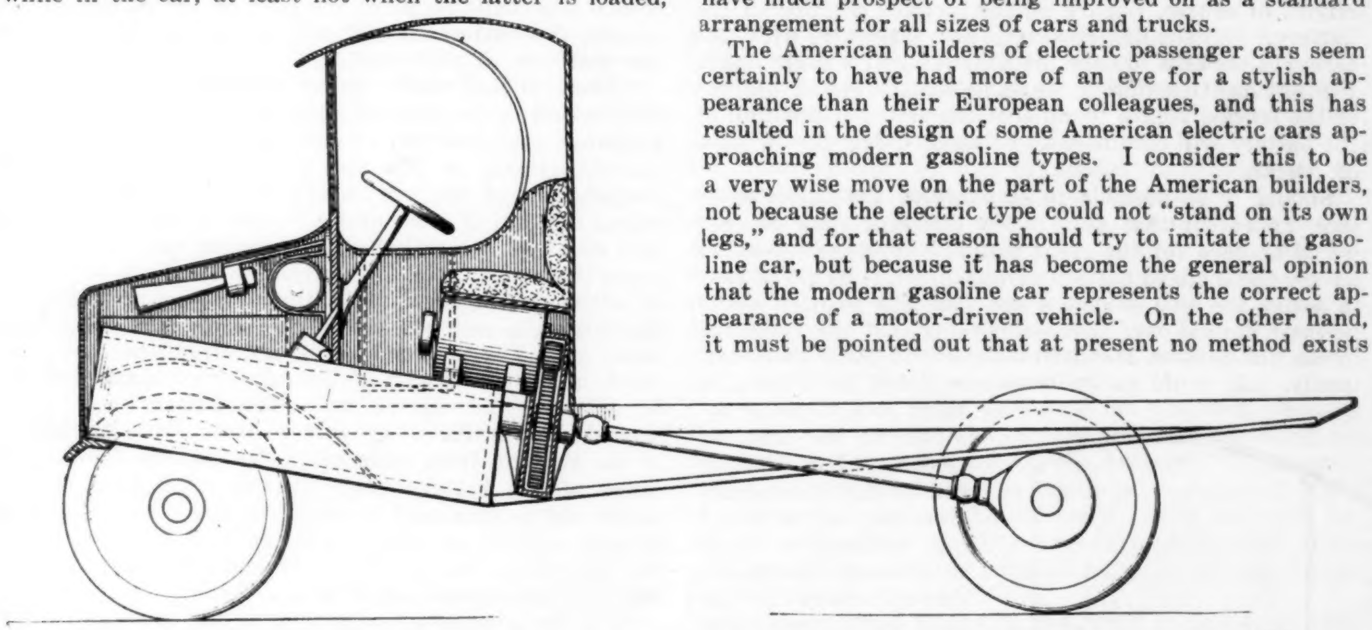
On most American trucks the underslung battery arrangement is now used. Among the advantages of this arrangement are that it is suitable for the exchange system, it makes the truck shorter and brings the center of gravity of the truck low. The principal disadvantages are that the battery is somewhat exposed to splashing, snow, etc., and that it cannot be readily inspected while in the car, at least not when the latter is loaded, and furthermore that the appearance of the truck becomes heavy and rather unattractive. Some other drawbacks of the underslung battery arrangement will be discussed later in connection with the question of a suitable drive. The appearance probably does not matter so much when it concerns a truck, but in the case of a passenger car it becomes of such great importance that the underslung battery arrangement can for this reason scarcely be chosen for the standard light car.

The arrangement of the battery on top of the frame, underneath and behind the driver's seat, is now rarely used except for light delivery cars of the truck type. This seems to indicate that it has not met with favor in the United States, and it is not much used in other countries either. Although the protected position and easy accessibility of the battery must be factors of considerable advantage, it is, however, obvious that this arrangement cannot in any case be used for passenger cars of modern design.

Finally, the arrangement of the battery in front underneath a hood is not used by any American maker at the present time, to my knowledge. The reason is, evidently, that there is not enough room for a sufficiently large battery of the present standard cells without making the hood very big and cumbersome. By using special extra high cells, one might possibly be able to get in a large enough battery, without the hood being objectionably large looking. There are other disadvantages, as such an arrangement would make steering difficult, bring the center of gravity higher than is suitable and increase the danger of skidding. On the other hand, it must be admitted that from the points of view of accessibility and a protected position of the battery, the arrangement is very satisfactory.

From the foregoing it must be apparent that none of the arrangements known at present are very suitable, at any rate for the passenger cars. This must, of course, also be the reason why builders of these cars still use divided batteries to be able to give their cars an attractive appearance, although the drawbacks of this arrangement of the battery must be evident to everybody. None of the present battery arrangements seem, therefore, to have much prospect of being improved on as a standard arrangement for all sizes of cars and trucks.

The American builders of electric passenger cars seem certainly to have had more of an eye for a stylish appearance than their European colleagues, and this has resulted in the design of some American electric cars approaching modern gasoline types. I consider this to be a very wise move on the part of the American builders, not because the electric type could not "stand on its own legs," and for that reason should try to imitate the gasoline car, but because it has become the general opinion that the modern gasoline car represents the correct appearance of a motor-driven vehicle. On the other hand, it must be pointed out that at present no method exists of arranging the battery in such a way that an electric passenger car can be given an appearance in accordance with modern demands and at the same time allow of a convenient method of battery exchange.



AN ELECTRIC TRUCK HAVING THE STORAGE BATTERY LOCATED AT THE FRONT OF THE VEHICLE IN AN INCLINED POSITION

In my efforts to find a solution of this problem of battery arrangement, I have started from the following basic requirements for a satisfactory battery arrangement:

(1) An undivided battery compartment for a battery large enough to be contained in one tray, or, if several trays are used, these should be held together by a suitable iron cradle to form one unit

(2) The battery should be easy to exchange

(3) Ready inspection should be possible when the battery is in the car

(4) The center of gravity of the battery should preferably be low

(5) The battery should be arranged in such a way that it does not cause the appearance of the electric car to deviate from that generally approved of for other modern motor-driven vehicles

In the following arrangement these conditions are fulfilled and there are some other advantages besides. As shown, the battery is placed in the front of the car in a slightly inclined position, and extends underneath the floor of the driver's place and the driver's seat. The bottom of the front part of the battery is so high that it does not interfere with the front axle, even if this be made straight, and the rear end of the battery does not need to lie lower than some of the machinery parts on the gasoline car or the running-board on the modern passenger cars. As shown, the electric vehicle with this battery arrangement can be given exactly the same appearance as a modern gasoline car or truck.

For trucks it might perhaps in some cases be preferable to use a somewhat modified arrangement with the battery placed in a horizontal position. In this case the front end of the battery should preferably be somewhat lowered and the rear end raised. Through this modified arrangement of the battery the driver's seat must come a little higher than usual, but this might not be objectionable on a large truck.

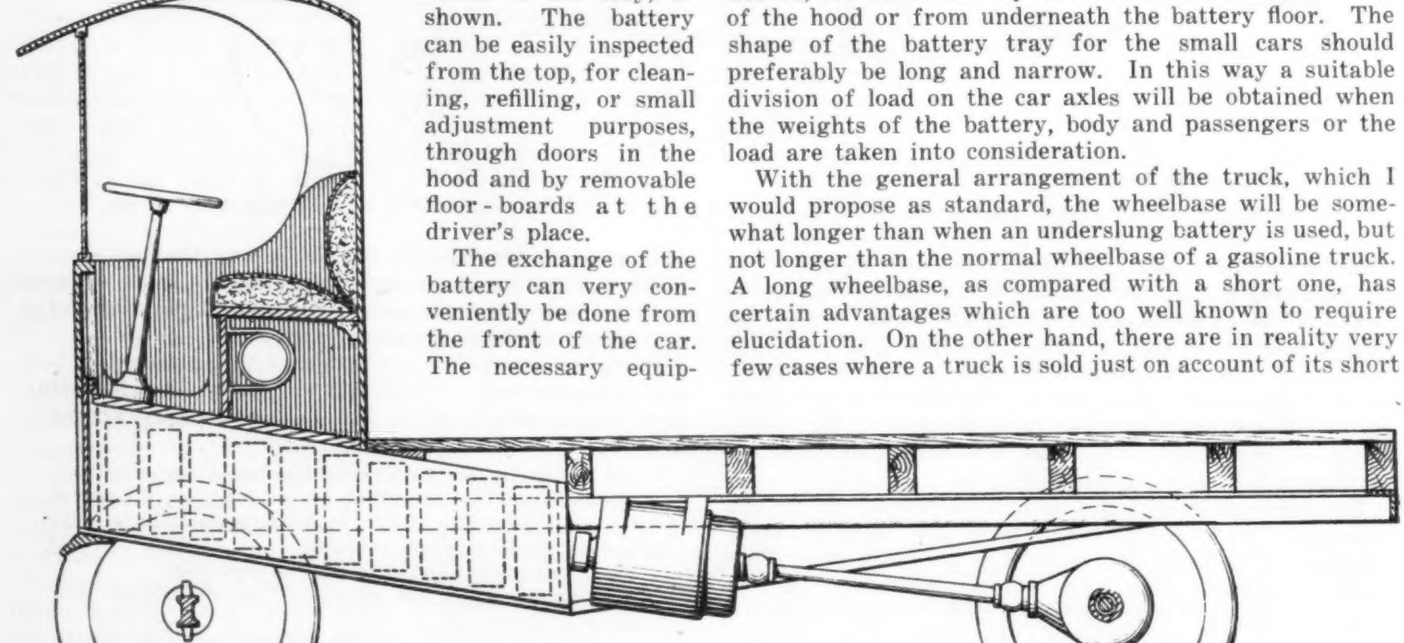
In criticizing the proposed battery arrangement one might, of course, remark on the inclined position of the battery. It should, however, not interfere with the action of the cells to have them standing at a slight angle. I might mention that in working out the proper designs of the trucks, I have found that the actual inclination of the battery will only need to be about 6 deg. for all sizes of trucks.

Should it be possible to standardize the batteries to such an extent that only a few different sizes of cells would be used for the great majority of electric vehicles having the inclined battery arrangement, it would be easy to design the cells in such a way that this position would be their normal one. Even supposing that one preferred to use the present standard cells and to place them vertically, this could easily be accomplished by arranging them in a stepwise position in the tray, as shown. The battery can be easily inspected from the top, for cleaning, refilling, or small adjustment purposes, through doors in the hood and by removable floor-boards at the driver's place.

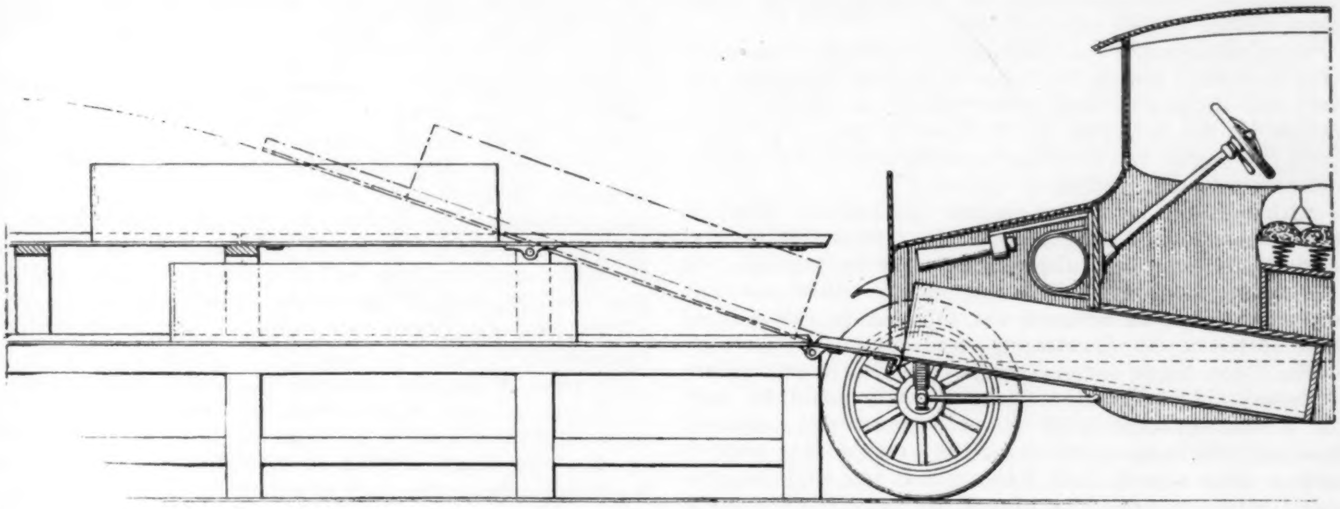
The exchange of the battery can very conveniently be done from the front of the car. The necessary equipment for this is probably less expensive than the elevators built into the garage floor, cranes, etc., used at present for quick exchange. Especially where a great number of trucks need to exchange their batteries at the same time, as might be the case in a large garage, it will be seen that this could be done in a very simple way from a platform, level with the front end of the battery compartment, to which the cars could be driven up close beside one another. The operation could probably also be done quicker than with other existing methods, as the fresh battery could stand ready on the platform and the discharged battery pulled out of the car on rails arranged on about the same angle as the rails on which the battery is resting in the car and thus constituting a continuation of these rails leading up to a second upper platform, the fresh battery standing on the lower one. The battery exchange could be performed by hand, by some suitable winch in the small stations and by motor power in the larger ones. The batteries could be transported in a larger station between the platform and the charging room by a car running on rails at the back of the platform, and equipped with a track which is a continuation of the rails on the platform. Of course, the batteries could also be charged standing on the platform, if preferred.

There should really be no objection to pulling the battery out in the inclined position—on the contrary, the exchange can probably, as previously mentioned, be performed quicker in this manner, as the battery can be brought out of the way in the same operation as it is pulled out, but if some prefer to pull it out horizontally, this could be accomplished by running the car down a ramp into a pit or by lifting the rear end car by a jack or other arrangement. By the proposed arrangement the battery is very well protected against dust, splashing, snow, etc. The exchange being done from the front, the whole of the lower part of the battery compartment can be enclosed and water-tight. The battery can, when needed, be ventilated by forced draft from the front of the hood or from underneath the battery floor. The shape of the battery tray for the small cars should preferably be long and narrow. In this way a suitable division of load on the car axles will be obtained when the weights of the battery, body and passengers or the load are taken into consideration.

With the general arrangement of the truck, which I would propose as standard, the wheelbase will be somewhat longer than when an underslung battery is used, but not longer than the normal wheelbase of a gasoline truck. A long wheelbase, as compared with a short one, has certain advantages which are too well known to require elucidation. On the other hand, there are in reality very few cases where a truck is sold just on account of its short

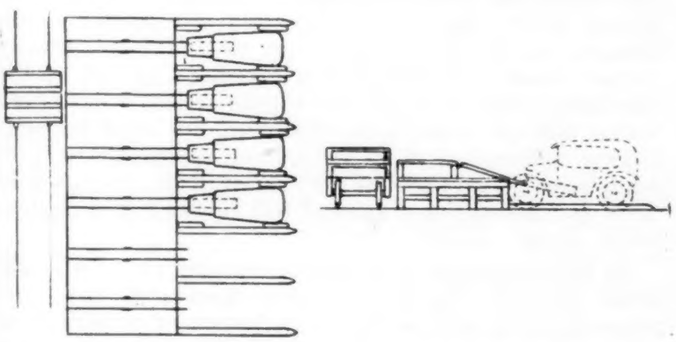


AN ELECTRIC TRUCK HAVING THE BATTERY CELLS ARRANGED LIKE A FLIGHT OF STAIRS AND THE SPEED REDUCTION GEAR CASE BOLTED DIRECTLY TO THE DRIVING MOTOR



An Arrangement for Exchanging Storage Batteries in Which the Battery Is Drawn Out of the Vehicle on an Inclined Track and Placed on the Upper Platform, While the Fresh Battery Is Located on the Lower One

wheelbase. However, I want to point out that the proposed battery arrangement lends itself just as well to a short wheelbase design. The arrangement of the battery



A Battery Exchange Station in Which the Batteries, After Removal from the Vehicles, Are Transferred by a Car to the Charging Room

compartment is identical in both instances, but the cab is moved forward and raised somewhat. There is nothing to prevent the wheelbase in this case being made even shorter than is possible with the underslung battery arrangement. This feature might be advantageous for tractor designs.

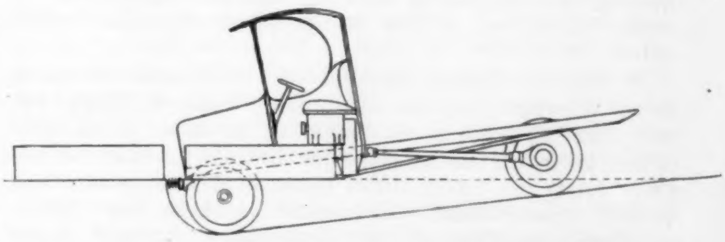
After having thus tried to criticize the proposed battery arrangement as conscientiously as possible, I cannot find that any of the objections which might be raised against existing methods are applicable to this. The advantages, on the other hand, will be better realized after various other questions, particularly in connection with the drive, have been considered.

One might, of course, remark that the batteries will in the future be so much improved that a battery of large enough capacity might have room underneath the hood alone, and without the other objection to this arrangement. It is likely, however, to be a long time before this will be the case, and it will then probably be preferred rather to increase the mileage of the cars with the improvement of the batteries, than to reduce the size of the batteries, particularly when the size does not in any way cause inconvenience. It must also be noted that if in the future the use of a smaller battery should be preferred, this can easily be accomplished without any alteration of the general design of the car or of the battery exchange facilities in the service stations.

It might finally be pointed out that with the proposed arrangement of the battery a very simple and effective frame for the chassis can be designed. This design of the frame might become of special importance from a manufacturing point of view in case of the proposed standardization of the truck sizes, as the same main frame members could probably be used for any truck belonging to the same group by simply modifying the truss rods to suit the different requirements. The frame might also be built of pressed steel, for instance, with the whole side of the battery compartment made in one piece with the main side frame member.

It remains now to be seen how the proposed alternatives for the standard battery units could be suited to the proposed arrangement of the battery. The standard battery units should, as previously mentioned, have the long and narrow shape, which would probably be the most suitable form for all the light-duty cars. Two of these units could without difficulty be arranged side by side in trucks of all sizes.

The use of three of the same battery units side by side for the 5-ton truck would, however, not be very feasible in the proposed way, without the hood getting too broad and clumsy in appearance. Besides, the gage also would probably have to be increased above the present practice. If one instead used the underslung battery arrangement for the 5-ton truck, it would, of course, be entirely feasible to carry through the battery unit idea in accordance with that arrangement on this size of truck as well. It seems doubtful, however, if the advantages of such an arrangement would be sufficient to counter-



An Alternative Method of Battery Exchange in Which the Truck Runs Down a Ramp and the Battery Is Drawn Out on a Level with the Platform

balance the disadvantages of not being able to use a uniform design for all sizes of cars.

With reference to the alternative indicated in the table, this is worked out on the basis of present standard battery cell dimensions and with a view to a suitable application of the batteries to all sizes of cars and trucks with the use of the proposed arangement of the battery compartment and design of chassis.

Although the universal electric car perhaps must be looked upon as a future proposition, I do not think that it need be long before one can begin to consider the realization of this type of car, and I would certainly make provision beforehand for this car in the general plan of battery compartment standardization.

The 1-ton truck battery seems to me to be rather unnecessary, if you have a battery which could be used for a delivery chassis of about ¾-tons load capacity. However, the 1-ton truck is at the present date used to such a large extent, that I thought it advisable to provide for this size of truck as well, so that, if it cannot be avoided, it should rather be included than interfere with the general scheme of battery standardization.

In working out the battery plan as regards the dimensions, I have followed the principle that the height and the width of the battery compartments should be standard, and correspond in such a way that there would be only one height and but two standard widths, the one being a multiple of the other. Further, I have had the interchangeability between the two battery units in view and provided for this as far as possible, so that, for instance, a small battery unit can be used instead of a large one for emergencies.

The Drive

The question of drive is closely connected with that of the number of motors to be used and their arrangement. It would be a very large undertaking to give an account of the different motor arrangements which now exist or have been in use in the United States and other countries, and I think that it is not at all necessary in this connection. It really seems as if the many possibilities which offer themselves for the solution of this problem have only complicated matters and delayed the final solution. The motor arrangement is, of course, to a great extent dependent upon the battery location, and the uncertainty of the latter has also added to the difficulty of arriving at a final decision regarding the former.

On the gasoline car the right place for the engine was very soon found and agreed upon. As a result of this the drive developed in one certain direction, and rather soon took the form of the propeller shaft drive, which is now almost universally adopted. If the further arrangements in connection with the drive of the gasoline car still vary to some extent, it is only in details which do not interfere very much with the general design of the cars and trucks. On trucks it is of special importance that the arrangement of the body for different purposes, loading and unloading devices, etc., be independent of minor variations in the design of the propeller shaft drive.

Most of the electric truck builders still retain the chain drive, although they are all probably ready to admit that this form of drive is no longer up to date. It is easy to see, however, that it is rather difficult for them to get away from the chain drive because of the underslung battery arrangement which most of them use. Some manufacturers using the underslung battery have adopted the propeller shaft, but to do this thev have had to divide the battery. Although, of course, both parts of the battery can be built together, and the exchange performed as if the battery were in one tray, I do not consider this arrangement very satisfactory.

Before I found the proposed solution of the battery location, I was, however, rather in favor of the divided battery arrangement mentioned because of the possibility of getting away from the chain drive and employing a totally enclosed drive instead and also because of certain advantages in connection with the arrangement of the motor, such as the simplification of the wiring, etc. However, as I realized that this arrangement could not very well be used for passenger cars and was not very attractive for delivery cars either, I was never entirely satisfied with it.

In considering the number of motors to be used, I shall not say very much about the four-motor drive because if this should be used at all, I think it can only be for very heavy trucks in exceptional cases. Those instances where the four-wheel drive would be particularly advantageous correspond to the comparatively small field where the electric truck should not be recommended.

For the great majority of cases the choice is between the use of one or two motors. The use of one motor cannot, of course, be less advantageous on the electric than on the gasoline car. But the possibility of very convenient and wholly satisfactory arrangements of two motors on the electric vehicle might account for an inclination to use this arrangement to obtain individually driven wheels. In view of the advantage offered by the two-motor drive it would, until quite recently, have been rather difficult to decide on this point, but since the self-locking differentials were brought on the market and already seem to have proved very satisfactory, there seems to be no substantial argument left in favor of the two-motor drive.

On the other hand it is evident that the use of a single motor involves considerable advantages over the two-motor drive in many ways. The former arrangement is simpler than if the same horsepower be divided between two motors, the motor efficiency is higher, the weight of one motor less is saved, the number of wearing parts is less and also there is less trouble with oiling and inspection than when two motors are used. I think, therefore, that there cannot any longer be much doubt that the use of a single motor is the only correct thing for all electric vehicles, except possibly for very large sizes or for very special purposes.

Supposing, therefore, that the question of the number of motors to be used for the standard electric vehicles were considered as definitely settled, the choice of drive would be considerably simplified even though it would still give ample room for a great variety of design. The American passenger car builders, with few exceptions, seem to have already adopted the propeller shaft drive. The comparatively high speed of the passenger car makes it possible to use single reduction gearing, without the motor being too heavy and inefficient. When double reduction must be used, however, as on the trucks, the chain drive is still used in most cases, as previously mentioned.

A method of arranging the motor is shown with the aid of which it would be possible to obtain a drive with enough speed reduction to permit the use of a motor of considerably higher speed than is now ordinarily used, which might be advantageous. The same arrangement could also be used for cars and trucks of all sizes. As indicated in the illustration, the motor is placed under-

neath the driver's seat and suspended in a fixed position on top of the rear end of the frame which carries the battery. In placing the motor as high as this, there is ample room for the spur or herring-bone gears of a high-speed reduction. It would evidently also be possible to vary the speed within a wide range by changing the diameters of the two spur wheels without any further changes whatever. From the big spur wheel a propeller shaft, provided with one or two universal joints, is connected with the rear axle in some well-known fashion. All the gears are, of course, enclosed and run in an oil bath in the customary way. The arrangement of the spur gears in connection with the motor as proposed is in itself a very simple and approved method, extensively used for many different purposes. With this arrangement of the motor and drive it will be possible to use some suitable standard rear axles, and the electric car builders can take advantage of improvements made on these in the same way as is now done in the case of gasoline cars. I would, however, not recommend the worm-drive rear axles for electric cars.

In the proposed location the motor is very well protected in every way against shocks, vibration, dust and water. The motor is also readily accessible. The small portion of the battery underneath the motor is easy to reach from each side of the latter.

The wiring will, of course, be greatly simplified, and consequently more reliable, partly because of the motor being so near the controller and the battery and partly through its being fixed in position. It must also be considered an advantage, specially on a truck, that through the proposed arrangement all the principal parts of the machinery, such as the motor, the controller, the whole wiring and the battery, are quite separated from the load-carrying platform, in the same way as on the gasoline truck.

Finally, the proposed arrangement possesses a considerable advantage in connection with the electric passenger cars, as it allows the use of bodies which can always follow the lines and styles of those used for gasoline cars. The body of the former can thus always be kept up to the mark just as easily as with the other type of car. Regarding the trucks, it might often be of great advantage to be able to use on the electric vehicles any kind of body arrangement designed for the gasoline trucks, such as, for instance, standard exchangeable bodies or other time-saving loading and unloading devices, or designed for special purposes such as for the fire department, for street watering and cleaning, for busses, etc. There is, of course, nothing to prevent some differences in the arrangement of the motor and drive without a disturbance of the plan of standardizing the batteries, which is by far the most important matter.

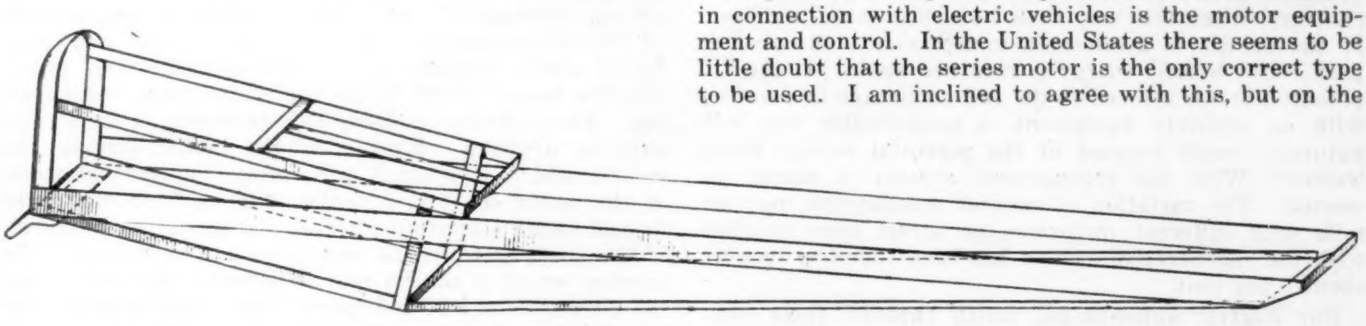
Before leaving the subject of the drive, I should like to call attention to another kind of speed reduction called the "turbo gears," which is made in the United States. This, I think, could be used very advantageously in connection with electric automobile motors. The gear case could be bolted directly to the motor. An advantage of this kind of gear is that it is perfectly balanced and also practically silent.

With this arrangement the motor could be placed so that the propeller shaft has a practically horizontal position and at the same time can be given the most suitable length, thus eliminating the requirement of a supporting bearing. The whole arrangement should no doubt form a clean and simple looking design, which would work very satisfactorily. It also possesses the advantage that the whole of the top of the battery is left free.

With reference to the proposed spur gear arrangement, I want to point out that this could also very well be used in the design shown for an electric truck. In this case, however, the motor would have to be placed either beside the battery compartment, turning it about 90 deg. around the propeller shaft or behind the battery, if the smaller wheel diameter is not made very large.

The Motor Equipment and Control

A question of special importance to be considered in connection with electric vehicles is the motor equipment and control. In the United States there seems to be little doubt that the series motor is the only correct type to be used. I am inclined to agree with this, but on the other hand I also consider the advantages of regeneration so important that a motor equipment cannot be considered perfect if it does not provide possibilities of utilizing, by regenerative braking, the potential and kinetic energy of the car going down hill and slowing down.



A Suggested Form of Chassis Frame in Which the Framework of the Battery Compartment Is Included

Several European makers use shunt or compound motors and can then, of course, obtain the regenerative action of the motors. However much I am in favor of regeneration I would not care to sacrifice the series motor to gain regeneration. It does not seem necessary to do this as there are some methods of making series motors regenerative, although these as yet do not seem to have become very well known either in the United States or in Europe. If these methods are known, it is evident that designers have not as yet realized the advantages of regeneration for electric vehicles. It must be admitted that the topographical conditions in many of the American cities, where electric vehicles have found extensive use, are not of the kind to show any very substantial savings through regeneration.

Before I go any further in describing the system which I have in mind, I should like to say a few words about the advantages of regeneration in general. According to different topographical conditions it seems to have been proved that the savings in current through

regeneration on electric vehicles may amount to as much as from 10 to 25 per cent. If one should figure an average saving of 15 per cent the direct saving in money through the reduced current consumption is of but minor importance. On the other hand, an increased mileage of from 70 to 80 miles is a rather considerable advantage. Another advantage is the excellent braking qualities of the regenerative system, inasmuch as such braking is automatically non-skidding. There will as a result be a considerable saving in the wear of tires. There will, of course, also be quite a saving in brakes and very little trouble with brake adjustments, as in going down hill or slowing down the mechanical brakes need never be used. It also gives the driver a feeling of safety to have his car in just as good control going down as going up a steep hill. Further the boosting effect of the regeneration has a good result on the battery, particularly in the case of the Edison alkaline battery, which will result in maintaining a higher voltage, thus materially improving the average speed of the vehicle and correspondingly reducing the current demand on the battery.

Finally it has been proved from experience on street cars that with an ordinary series equipment the current consumption per car mile varies very materially according to how the controller is handled, and there is often found to be a variation as great as 50 per cent with different motormen. With the regenerative system, on the contrary, it matters very little how the vehicle is driven. If the vehicle is accelerated unnecessarily, the greater part of the kinetic energy is returned again. If the hill potential is not utilized to the full advantage in coasting with an ordinary equipment, a considerable loss will naturally result because of the potential energy being wasted. With the regenerative system it cannot be wasted. The variation of current consumption per car mile with different motormen on street cars supplied with the regenerative system has been found to be only about 5 per cent.

For electric automobiles, which through their very simple operation can be handled by almost any unskilled driver, this advantage of the regenerative system seems to be especially worth consideration, as very probably just because of the unskilled driving the actual saving will in the majority of cases be considerably higher than what might be expected when the gain is figured simply on the basis of topographical conditions. But the other advantages previously mentioned are also really so important that the regenerative system of control seems well worth universal adoption on electric vehicles if this can be done without giving up the series motor and without great complications.

The system of regenerating series motors invented by Robert Lundell is characterized by a separate source of current supply of low voltage being connected across the terminals of the field of a series motor. Various methods can be used in supplying this current. In one case Lundell uses a separate storage battery of a few cells and in another a separate small motor-generator set. Through the additional voltage from the separate battery or from the motor-generator set, the series motor can be given the desired shunt characteristic and be made to supply current to the battery. The voltage of the source of current supply can be regulated and thus the field strength and the speed of the series motor varied. It is, however, to be noted that any ordinary series motor is not capable of great speed variation, because, when the field reaches a certain low limit, the motor will not operate satisfactorily. To obtain a wide speed variation it is therefore necessary to use an interpole motor, which will permit the use of a weak field.

On one little electric car recently brought out in the United States, a modification of Lundell's regenerative system with a battery source of supply seems to have been introduced, but this is, to my knowledge, the only case, here or in Europe, where regenerative series motors have been used for electric vehicles. I do not think, however, that the method with an extra battery will prove very satisfactory on account of the troubles connected with the charging of this battery.

The other method, with the source of current supply consisting of a small motor-generator set, seems to have met with great success on some electric railroads in this country. I believe that this method has great possibilities for heavier traction, such as railroads, street cars, etc. For storage battery driven cars, I am rather doubtful about the suitability of Lundell's method of using the small motor-generator set as a means of accomplishing the speed variations of the motor during acceleration, partly because I am afraid that this method of control will scarcely prove as simple and reliable as some of the present methods used on electric vehicles and partly because of the loss of current taken from the battery in running the motor-generator set.

For these reasons I prefer to use some one of the present methods of control for acceleration and, instead of the motor-generator set, to have a small generator which could, through some suitable mechanical transmission, be connected to the big motor when regenerating. The method for doing this is shown in an accompanying drawing. Here *a* is the motor driving the vehicle and *b* is a small generator. On the extension of the motor shaft is a brake drum *c*, from the outer face of which a friction wheel *d*, sliding on the extension of the shaft of the small generator can be driven. The friction wheel *d* can be moved between the center and the circumference of the face of the brake drum by the lever *e*, the wheel being pressed against the face of the drum by a spring *f*. The face of the drum is slightly recessed in the center so that the friction wheel shall not rest against the former when in this position. Through moving the wheel in an axial direction on the generator shaft, or radially across the face of the drum, the wheel, and thus the small generator, can be given any speed between zero and a certain maximum. The lever *e* is pivoted at *g* and is made in one piece with the lever *h* which, through a rod or wire *i*, is connected with the lever *j* that is pivoted at *k* and is in one piece with the pedal *l*. The friction wheel *d* is held in a neutral position by a spring *m*.

Through regenerative electric braking, by this arrangement, the vehicle can be brought down to a very slow speed and is afterwards stopped when desired and held by a mechanical brake. This mechanical brake may, for instance, be arranged so that a brake band *n* acts on the brake drum, by moving the lever *o* which is connected with the lever *j* and the pedal *l* by the rod *p*. When the lever *o* is not actuated by the pedal *l*, the lever is, through the spring *q*, held in such a position that the brake drum runs free of the brake band. The rod *i* is connected to a spring *r*, which is so stiff that it is not materially influenced before the lever *h* is checked by the stop *s*. The rod *p* is supplied with two stops *t* and *u*, arranged on both sides of the lever *o* in such a way that the lever is not moved by the rod *p* when the pedal *l* is

depressed until the lever *h* is checked by the stop *s*. The main circuit is broken by the lever *o* and a switch *v*, before the brake band *n* acts on the brake drum.

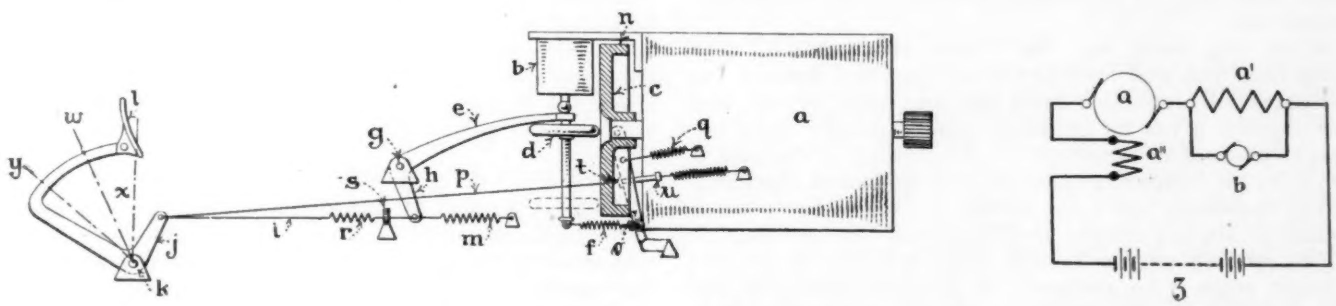
The electric and mechanical brakes are brought into action in the following manner: By moving the pedal *l* from the position shown to position *w*, the lever *j* is moved from position shown to position *x*. Further, the lever *h* is actuated by the rod *i* and the spring *r*, whereby the latter, however, is not materially stretched, from the position shown to the one where the lever *h* is checked by the stop *s*, the lever *e* is lowered and the friction wheel *d* also is moved from its neutral position to the position of maximum speed, which is indicated by dotted lines.

The mechanical brake is not at all influenced by the movement of the pedal *l* from the position shown to position *w*, but through the rod *p* the stop *u* is moved so that it will come close against the lever *o*, without, however, influencing this. In continuing the movement of the pedal *l* from position *w* to position *y*, in the first place the main circuit is broken at *v* by the lever *o*, which thereafter operates the brake band. The lever *h* remains against the stop *s*, and the spring *r* expands, through the action of the rod *i*, as much as is needed to allow for the movement of the lever *j* from position *x* to position *w*.

sufficiently to prevent it from being made a very extensive and attractive business proposition, if dealt with in the right manner.

The batteries have in the last few years been improved considerably and it can be expected that the improvements will continue. The electric cars will benefit from these improvements automatically, and their field of usefulness will increase. It will probably take a long time before the capacity of the battery has been increased say 100 per cent, but we might arrive there sooner than we expect and then the electric car will have become a very serious rival of the gasoline type. It would, however, be a mistake to wait until such a battery is available before the electric vehicle industry is organized, and the product utilized to its full extent for all the numerous cases where it can already show indisputable advantages over all other kinds of vehicles. One must bear in mind that the difficulties of a standardization will increase with every year.

Attempts at such standardization have hitherto not met with anything like the required adherence. The reason for this is probably that the right prerequisites for standardization have been lacking. This, on the other hand, depends upon the fact that it has not thus far



A Suggested Scheme for the Control of the Speed of Electric Vehicles and the Application of the Brakes

When the pedal *l* is released these actions take place in the reverse order. The lever *o* is thus returned by the spring *q*, the friction band *n* is released from the brake drum and then the main circuit is closed at *v*. The lever *h* is returned by the spring *m* from bearing against the stop *s* to the position shown, and the lever *e* and the friction wheel *d* again assume the positions shown, thus releasing the friction wheel, by a suitable arrangement, from the face of the drum, so as not to drag when the drum is revolving.

The above description is meant only to explain the principles of the electric and mechanical braking arrangements as I propose them. The detail designs may, of course, vary in many different manners. A diagram of the wiring is also reproduced, *o* being the armature of the series motor, a' the series field, a'' the interpole winding, *b* the small generator, and $b^{=}$ the storage battery.

Summary

Before closing this paper I wish to point out that there is no time to lose in carrying through the standardization of the electric car. It is true that it is to a certain degree still handicapped by the batteries but not

been possible to find or agree upon a suitable location of the battery in the car, and the solution of this problem must be considered as the key to standardization of the electric vehicle.

If one of the leading gasoline truck builders would decide to take up the proposition, or better still, probably, a new strong organization were formed for this purpose, I believe that the required standardization could be forced through, provided, however, that one could start out with the right design of chassis, particularly as regards the battery location. On the other hand, without that right design I think it would not be possible to carry through the standardization, however much energy, influence or money were spent upon the matter. If we have to start out in a smaller way it will, of course, take a longer time before we reach the ultimate goal, but if we only have the right design of chassis, we are sure to be working in the proper direction and will arrive there some day. When the correct design is brought out people are sooner or later bound to realize that it is the right thing for an electric vehicle, and when they do realize that they will buy it. Other builders of electric vehicles will consequently either have to follow suit or gradually drop out of the business.

Line Control and Power Steering as Applied to Tractors

By A. H. Wyatt[1] (*Member*)

Mid-West Section Paper

NO industry is attracting wider attention at the present time than the tractor industry. Even the first born of the automotive family, in its cradle days, never enjoyed greater distinction than that now being accorded the farm tractor. The tractor may well be called a product of destiny or a response to Old Mother Necessity. Despite the warning cry, "Back to the farm," which has been sounded throughout the land for a generation, the cities have drawn much of their increased population from the rural districts. As a result the farmer has for years been calling for help with which to produce his crops and the city dweller has been lamenting the high cost of living, all of which can be said to be due primarily and directly to the scarcity of farm labor and the increasing number of consumers over producers.

While the world war has drawn thousands of boys from the farm and created an international demand for greater food production from the American farmer, and has thereby given an immense impetus to the rapid advancement and development of the tractor in the past 4 yr., it was a foregone conclusion that American ingenuity would eventually meet the emergency and develop some means to aid the farmer and solve our food problem.

The modern tractor is still, none the less, in an embryonic state. As evidence of this, hundreds of engineers are today working on their own pet hobbies and theories for the development of a perfected commercial product. Despite this fact, the fundamentals of economy and practicability in the modern tractor are conceded by every engineering society, by every agricultural society and educational institution, by the United States Department of Agriculture, by all State governments, and, last but not least, by the ultimate consumer—the American farmer.

Different Types of Tractor

The prospective buyer who goes into the market with the intention of purchasing a tractor is confronted with many confusing differences in design and construction. There are drive-wheels in front and drive-wheels in the rear. There are two-wheel, three-wheel and four-wheel tractors. In addition, there is the caterpillar or crawler or track-laying type. Some are combinations of both wheel and track-laying type. There is even the walking type that has neither wheels nor caterpillar traction. There are gear-driven and chain-driven tractors; friction-driven and even belt-driven. Some drives are open and exposed, while others are enclosed and operate in oil. Each and every variety can be said to possess commendable features, and virtually all have their weaknesses.

To my knowledge, no serious move has been made toward general standardization, and in my opinion several more years of development will be required before anything along this line can be accomplished. I base my opinion on the fact that no engineer is competent to design a tractor who has not thoroughly familiarized himself with national agricultural conditions. Such knowledge can be acquired only by actual experience in the field. There alone can be learned the conditions under with tractors are used and the abuse to which they are subjected by inexperienced operators in the various soil and climatic conditions found throughout the country.

Much is expected and demanded of the modern tractor under a wide range of conditions. It must be practical, economical and adaptable to the individual requirements of each farmer, but, all else being equal, the thing most desired by every farmer is one-man operation under all conditions. This can be accomplished only when the operator is seated on the implement or vehicle being operated by the tractor and from his position he must have absolute control of the tractor itself. I maintain that the most practical means of thus controlling the tractor is by flexible lines. It therefore follows that the tractor must be power-steered.

A Line Controlled Tractor

We have progressed in the direction of one-man operation and line control. Every operation of our tractor is controlled by lines. By the use of lines it is possible for the operator to go back any desired distance from the tractor and yet retain as perfect control of its operation as if he were sitting on the machine itself, having within easy reach all the levers of the implement or vehicle. This obviates the necessity of having one man on the tractor and another on the vehicle or implement. While some tractor implements are constructed so that they can be operated from the seat of the tractor, there are a greater number that require an operator on the seat of the implement. It is a decided advantage for the operator to have all his work in front of him, and this advantage is made possible by the use of line control. For example, we accelerate or retard the speed of the engine, we steer to right or left, we throw the clutch in and out and change all gears by lines; from the implement or from the ground we start, stop, back-up, turn to right or left and vary the speed of the tractor by this simple means.

Before proceeding to a discussion of the many advantages of one-man operation and line control, you should know something of our system of mechanism.

First of all, the tractor is steered by power. The power is taken from the camshaft of the engine at the rear end between the last cylinder and the bell-housing of the flywheel; from there it is transmitted through small bevel gears to a splined shaft upon which are keyed two 2-deg. leather cone clutches, with a collar between them in which operates a fork that holds the clutches in a fixed position while they are not in use by tension springs. The shaft upon which the shifting fork is fastened is attached at one end to a lever that works at right angles to it and passes through a hole in the clutch operating lever, which has a T-shaped head. The driving lines are fastened to the extreme ends of the cross-head of this lever, making it possible to steer the

[1]President and general manager, Automotive Corporation, Fort Wayne, Ind.

tractor, no matter in what position the clutch operating lever may be. On the shaft upon which the two small clutches are keyed and arranged so that the clutch operates in them, are two bevel gears constantly in mesh with a third bevel gear; these gears are loose on this shaft and do not turn until the clutch is engaged in them. As soon as the clutch is thrown into either gear the entire steering mechanism is set into operation and the direction in which it turns depends upon which clutch is engaged. The third bevel gear, which operates in connection with the other two, is keyed to a shaft that runs to the rear of the machine. On the other end of this shaft is securely keyed a worm which meshes with a worm gear, making it irreversible; on the bottom of this is a pinion operating in a segment the full width of the tractor. The segment is on the sub-frame or truck, which is pivoted close to the axle of the tractor, and the sub-frame is supported on the other end by two small trailer wheels. At the secured end of the T-shaped clutch operating lever, is an eight-tooth ratchet. Upon the other end of this ratchet shaft is keyed a star-shaped cam with four points, having eight positions in all, one for each tooth in the ratchet and one for each space between the teeth. The clutch lever operates on this cam and the other end is connected to a dashpot which allows the clutch to be operated at a speed of 3 sec. every other time the lines are pulled back. The first 4 in. of pull on the lines retards the engine speed, the balance of the pull operates the clutch, every pull alternately throwing the clutch in and out, out when the clutch lever is on the point of the star cam, and in when it is between points. The gears are shifted by two cams in the same general manner in which the clutch is operated, and, while we recommend the use of the third line for shifting gears, at the same time this can be done by connecting to the two driving lines, in which case greater care is required in operation. It also complicates the device somewhat. The cams on the gear-shifting device work together at all times and are designed so that when one lever is being operated the other is held in a stationary position. The arrangement is such that one lever cannot even be engaged until the other is in a neutral position.

It is difficult to describe the operation of our line control. Although apparently complicated, the whole device weighs less than 25 lb. and is very simple.

Since July, 1918, we have made many tests in all varieties of soil and have demonstrated to our own satisfaction, and before thousands of spectators in various communities throughout the Middle States, that our system of line drive control is practical, and that through its use the extra man is dispensed with in each and every operation of the tractor.

Advantages of Line Control

The advantages of line control over lever and wheel control and hand-steering are many and varied. I group them as follows:

(1) It permits one-man operation under all circumstances.

(2) The operator always has all of his work before him.

(3) The operation of the tractor, including steering, requires practically no effort on the part of the operator.

(4) It does not require special instruction or a skilled and high-priced mechanic. A woman or a boy over 10 yr. of age can operate the tractor as easily as a strong man. Practically every operation of the tractor is the same as that necessary in driving horses and requires no more effort. The lines are always loose except when operating the clutches or shifting gears.

After the engine is started the operator takes the lines in his hand and walks back to the plow or other implement, which has previously been attached to the tractor. He takes his seat on the implement and pulls the lines as far back as they will go, which operation releases the clutches. With the third line he shifts the gears in the transmission and as the clutch is engaged the tractor moves forward or backward in the direction desired.

(5) The operator is always away from the heat of the engine, out of the dust of the tractor and subject to no more rough riding than when being pulled by horses.

(6) With line control there are no extensions to make, as is the case when the steering-rod is lengthened to the required distance in other models of one-man operation. The lines can be made any length and the operator can go back and sit on the vehicle or implement without making the slightest change. He can likewise go from that position and occupy the seat on the tractor without making any changes. The tractor can be operated as easily from the top of a load of hay as from a plow or the tractor itself.

(7) The steering-gear, being irreversible, is always positively locked and can be set for a straight line or any circle down to 12 ft. in diameter.

(8) The engine speed and consequently the tractor speed are always under the instant control of the operator. A slight pull on the lines will retard the speed from 900 r.p.m. down to 100 or to any intermediate speed.

(9) The four gear positions, two forward, the neutral and the reverse, are controlled by the third line just as easily as if the operator had his hand on a solid lever. A signal on the side of the gear-shifting cams indicates the position of the gears.

(10) The seat for the operator can be changed as circumstances may require. In plowing, he sits directly behind the furrow wheel. In loading hay he goes up with the load. In binder operations he takes the binder seat, from which position he can manipulate all necessary levers. The same is true of mowing machines, manure spreaders, harrows, disks, seeders, etc.

It is no more desirable and convenient for the operator to be always on the tractor than it is for the farmer to do all his farm work while riding his horses.

The Discussion

QUESTION:—Is the transmission of progressive or selective type?

ANSWER:—Selective.

QUESTION:—How many wheels are steered?

ANSWER:—The tractor is steered by warping in the middle.

QUESTION:—What is the manipulation of the engine during steering?

ANSWER:—It steers as fast as the engine usually does, 900 r.p.m.

QUESTION:—Is there an automatic stop on the turning?

ANSWER:—Yes, a stop on the rear end of the main frame.

QUESTION:—Do I understand correctly that there are three lines to operate the tractor?

ANSWER:—Yes; the farmer generally holds two in his hands and sits on one.

QUESTION:—How is the throttle in the engine actuated?

ANSWER:—Pulling the lines the first 4 in. stops the engine.

QUESTION:—The effect is first on the engine and then on the clutch?

ANSWER:—Yes; but it is practically instantaneous.

QUESTION:—How is the engine clutch thrown in and out?

ANSWER:—Every other pull engages the clutch; every other one throws it out.

QUESTION:—How does the ordinary farmhand take hold of this machine?

ANSWER:—Easily. It is just like driving a horse; the lines are used in the same way.

QUESTION:—The farmer usually lets the horse take care of itself, however.

ANSWER:—This tractor will do the same thing. Set it in position and it will go in a straight line. We had a demonstration of a farmer who loaded hay, spread it around and ran the tractor at the same time.

QUESTION:—How large is the tractor?

ANSWER:—It is a two-plow machine.

QUESTION:—How is the brake operated?

ANSWER:—On the brake pulley by the same two lines. You pull both lines back as far as possible to operate the brake.

QUESTION:—How are plows hitched to the tractor? Is it necessary to take out the small wheels when attaching them?

ANSWER:—No.

QUESTION:—How do you arrange the lines so that the farmer knows which to pull?

ANSWER:—The lines come out of two holes in the back of the hood. You pull the right line to go to the right and the left line to go to the left and the gear-shifting line to go backward.

QUESTION:—The first 4 in. of pull on the lines controls the speed, I understand. How do you get intermediate speeds?

ANSWER:—By the distance you pull the lines back.

QUESTION:—When going up a hill it becomes necessary to change into low speed, how is it managed?

ANSWER:—Three jerks on the lines make the change from high to low.

QUESTION:—Is the clutch thrown out every time the gears are shifted?

ANSWER:—Yes.

QUESTION:—How is a short turn made?

ANSWER:—At the end of a furrow run the tractor up to within a few inches of the fence, pull the left-hand line, then drop the clutch in and turn while the tractor is standing still, just as with horses. The lines can be operated while walking at the side or from any position.

QUESTION:—Is the spark control automatic?

ANSWER:—Yes.

QUESTION:—Must the engine be running to shift gears?

ANSWER:—No.

QUESTION:—How is the engine cooling effected?

ANSWER:—By a pump.

QUESTION:—What speed can the tractor make?

ANSWER:—It is impossible to run a tractor hitched to a farm implement faster than 4 miles per hr.

QUESTION:—What is used in the grease-cups?

ANSWER:—Sometimes oil, sometimes kerosene or gasoline, depending on the season.

QUESTION:—It has always been my understanding that farmers use anything from tar to butter.

ANSWER:—It is a notorious fact that a farmer takes no care of his machines.

QUESTION:—Are the gears enclosed?

ANSWER:—Everything is enclosed.

QUESTION:—Is the engine mounted crosswise?

ANSWER:—No; lengthwise.

QUESTION:—Can the parts be reached easily?

ANSWER:—We have made every possible effort to have the parts accessible.

QUESTION:—How is it possible to get the differential out?

ANSWER:—I think you would have to take a wheel off.

SCREW THREAD COMMISSION GOES ABROAD

THE National Screw Thread Commission sailed for Brest from Hoboken, N. J., on July 13. The delegation consisted of Dr. H. C. Dickinson, physicist, of the National Bureau of Standards; Lieut-Col. E. C. Peck, representative of the Army, vice-chairman; Capt. John O. Johnson, representative of the Army; Com. L. B. McBride, at present attached to the American Embassy, London, representative of the Navy; F. O. Wells and Luther D. Burlingame, representatives of the American Society of Mechanical Engineers; H. L. Horning and Earle Buckingham, representatives of the S. A. E., and H. W. Bearce and Lieut. Robert Lacy, technical secretaries.

The party will meet some French engineers in Paris and then proceed to London, where arrangements have been made for an informal conference with the British Engineering Standards Association. It is expected that a tentative agreement will be reached with the British on pipe thread standards.

CADMIUM AS A SUBSTITUTE FOR TIN IN SOLDER

LABORATORY tests, together with manufacturing experience, point to a composition of 80 per cent lead, 10 per cent tin and 10 per cent cadmium as being practical for many of the purposes for which solder is required. This solder has been tried in the manufacture of tin cans, on roofing materials and for electrical joints with encouraging results in all cases. A test has also been made of it in the manufacture of automobile radiators with most satisfactory results.

The tensile strength of the cadmium solder is about the same as that of 40-60 solder, but the ductility is approximately twice that of the ordinary solders. The point of complete liquation is only slightly higher than that of solders of the ordinary composition, while the range of solidification is considerably greater. Because of the predominance of lead in the cadmium solder, the price of it is relatively low.—*Metallurgical and Chemical Engineering.*

Tractor Equilibrium

By D. L. Arnold[1] (*Member*)

Illustrated with Diagram

In Mr. Hewitt's article[2] with special reference to the weight on wheels, Mr. Hewitt has developed this formula:

The maximum drawbar pull multiplied by its lever arm from the ground to the center of the drawbar cannot exceed the weight on the front end multiplied by its lever arm equal to a distance from the center of the front wheels to the center of the rear wheels; or in other words:

$$P \times a = W \times b \text{ wherein}$$

P = the maximum drawbar pull in pounds
a = the distance from the ground to the center of the drawbar
W = the weight on the front wheels
b = the wheelbase

These factors are not the only ones entering into the reasons why a tractor will tip over. If the powerplant of the tractor has insufficient torque, regardless of the drawbar pull or the weight on the front end, it will be impossible to have a tractor tip over or pull its maximum drawbar pull. Therefore, the maximum torque of the engine and gear reduction on the tractor is as great a factor as those heretofore mentioned, if not greater. Taking these factors into consideration, the formula should be for the tractor equilibrium:

> Gear ratio multiplied by engine torque in inch-pounds equals the wheelbase in inches multiplied by the weight of the front end in pounds.

The cosine of the angle of inclination the tractor makes with a horizontal must also equal the maximum drawbar pull in pounds multiplied by the height of the drawbar from the ground, or in other words, the general formula is:

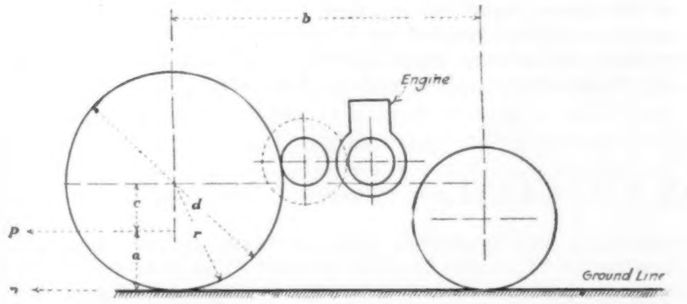
$$GT = bW \cos V = pa$$

The derivation of this formula is shown below.

The tractor front end is unstable when

$$GT > bW + pc \text{ or when}$$
$$pa > bW \text{ or}$$
$$GT > pa$$

a = Height of drawbar center from ground line in inches



b = Length of tractor wheelbase in inches
c = Vertical distance from drawbar center to rear axle in inches
d = Diameter of rear wheel in inches
G = Gear ratio or relation between engine and rear wheel speeds
G_r = Gear ratio reverse
G_1 = Gear ratio first speed
G_2 = Gear ratio second speed
G_3 = Gear ratio third speed
G_4 = Gear ratio fourth speed
M = Engine speed in revolutions per minute
p = Pressure at drawbar in pounds or drawbar pull in pounds
p_1 = Pressure between driving wheel and ground in pounds
T = Engine torque in inch-pounds
V = Angle above horizontal at which tractor stands
W = Actual weight of front end

Note:—The actual weight will vary with the angle at which the tractor is used, being greatest when the tractor is in a level position and decreasing as the angle increases. Neglecting changes in the center of gravity this weight varies as the cosine of the angle, hence W should be written $W\cos V$

r = Rear wheel radius
S = Rear wheel speed in revolutions per minute
F = Speed in feet per minute

When equilibrium of the tractor relative to ground movements is established

$$p = p_1$$
$$p_1 r = GT$$
$$pr = GT$$

For forward movements of the tractor GT must be greater than $p_1 r$.

The effect of drawbar pull on the front end is given below.

pc = Inch-pounds torque on the rear axle due to the drawbar pull p
pc/b = Additional weight effect added to the front end due to the drawbar pull p
bW = Additional weight effect added at the rear axle due to the weight of the front end only with tractor level
$bW\cos V$ = Inch-pounds torque effect at the rear axle due to the weight of the front end when inclined up from the horizontal at the angle V ($W\cos V$ will probably not be exactly correct and the tractor will have to be weighed at the angle V for the correct figures due to the changing the center of gravity)

Where sufficient engine torque is available to equal the effective inch-pounds of torque tending to hold the front end down the tractor front end will be in equilibrium. Equilibrium of the front end is established when

$$GT = p_1 r = pc + bW\cos V$$
$$p_1 r = pc + bW \text{ or}$$
$$bW = p_1 r - pc \text{ as}$$
$$p = p_1 bW = p\,(r-c)$$

[1]Chief engineer of special engineering, International Harvester Corporation, Chicago, Ill.

[2]Paper entitled "Principles of the Wheeled Farm Tractor," presented by E. R. Hewitt, consulting engineer, International Motor Co., New York City, at the 1919 Annual Meeting of the Society. The paper was printed in the February issue of The Journal, and the discussion at the Annual Meeting and the Tractor Meeting in Kansas City appeared in the April issue.

Substituting a, which is the equivalent of $r - c$, we have

$$bW = p\,(c + a - c) \quad \text{or}$$
$$bW = pa = GT \text{ for equilibrium}$$

Therefore the tractor front end will leave the ground and tip over backward when

$$bW < pa$$

The drawbar pull at equilibrium can be expressed by the equation

$$p = bW \div a$$

The rate of travel is expressed in either miles per hour or feet per minute. The speed in feet per minute equals the speed in miles per hour multiplied by 5280 and divided by 60, or 88 times the rate of travel in miles per hour. The speed in miles per hour is equal to the rate of travel in feet per minute divided by 88 or multiplied by its reciprocal 0.0113636.

The gear ratio is the relation of the engine speed in revolutions per minute to the rear wheel speed in revolutions per minute.

$$G = \frac{M}{S}$$

$$S = \frac{F}{\frac{d}{12}} = \frac{F}{0.2618 - d}$$

$$G = M \div \frac{F}{0.2618 - d} \quad \text{or}$$

$$G = \frac{M\,(0.2618 - d)}{F}$$

The source of motive power in the tractor is that force delivered at the end of the revolving shaft of the powerplant and is measured in inch-pounds torque or foot-pounds torque. The inch-pounds of torque at the rear axle then equals GT, neglecting efficiency of transmission.

Summarizing the conditions for equilibrium, we have

$$GT = bW = pa$$

$$G = \frac{bW}{T} = \frac{pa}{T}$$

$$T = \frac{bW}{G} = \frac{pa}{G}$$

$$b = \frac{GT}{W} = \frac{pa}{W}$$

$$p = \frac{GT}{a} = \frac{bW}{a}$$

$$a = \frac{GT}{p} = \frac{bW}{p}$$

The values for W will change approximately as the cosine of the angle of inclination the tractor makes with the ground, the best values being taken from the actual weight at various angular positions.

The general formula for equilibrium may thus be written

$$GT = bW\cos V = pa$$

Author's Reply

Mr. Arnold has carried out my idea in a very complete manner and he must be commended for finishing the theory. I did not attempt in my paper to make a complete working formula but only called attention to the fact of the front end revolving about the axis of the rear wheel if the power applied exceeded the weight of the front end as increased by the leverage. It seemed to me that any competent engineer could make his own calculation if the matter were brought to his attention.

HELIUM FOR AIRSHIPS

Helium will certainly always be considerably more expensive than hydrogen, but there are two factors which to some extent reduce the importance of this. The rate of diffusion and consequent wastage with helium is only half that obtaining when hydrogen is used. This will, of course, reduce considerably the amount of gas consumed while an airship is lying idle in the shed, though it will not affect the loss of gas occurring while rising during a flight. In addition to the saving thus effected, helium is believed to be easier to repurify than hydrogen; although, owing to the comparative cheapness of the latter, it is doubtful whether the matter has been seriously considered.

When the purity falls below a certain figure the present practice is to "rip" the envelope and allow the hydrogen to escape into the air, the envelope or gas bags being subsequently reinflated with fresh gas. With the advent of helium, the gas will presumably be exhausted by fans into a reservoir, from which it will be taken to a purifying plant prior to being used again. This will naturally result in effecting a great saving in the amount of the gas that will be required.

The question of production is also extremely important from the practical point of view. Plants under construction capable of turning out 50,000 cu. ft. of helium daily are mentioned. This amounts to 18,250,000 cu. ft. per annum, or 1,520,000 per month. If this represents the total output of all the plants under construction it is totally inadequate. An airship consumes roughly its total capacity in gas per month, so that one modern rigid airship would require more than the whole output.—*Aeronautics* (London).

COMPOSITION OF COAL

Coal is of vegetable origin formed from plants which have undergone decomposition under pressure and at a temperature not exceeding 300 deg. cent. The substance of coal may be separated into cellulose and bitumen by employing solvents; first pyridin, then chloroform and benzol. In the cellulose portion there are compounds which give, by dry distillation, phenol as well as compounds whose molecular structure is similar to that of the carbon molecule. It is improbable, therefore, that coal contains free carbon. Compounds are not numerous in the cellulose constituents. The bituminous constituents give compounds in which alkyle, naphthene and unsatisfied hydro-aromatic radicals are held together in large and complex groups. The presence of the aromatic group is doubtful. Under the influence of pressure the bituminous portion was strongly polymerised. Hydrocarbons are found only in the bituminous portion of the coal. Unsatisfied hydrocarbons (paraffin) are, however, present in small quantities only. The principal difference between the products of the distillation of coal at a low temperature and mineral oil is that in the latter there is no phenol which may be taken as proof that mineral oil has not been formed out of cellulose.—*Zeitschrift für angewandte Chemie.*

The Future Passenger Car

By E. H. Belden[1] (*Member*)

Semi-Annual Meeting Paper

In my opinion the future passenger car will be valued in proportion to its efficiency, appearance and comfort. For the past 2 yr. it has been my good fortune to be in touch with some very exhaustive tests of a passenger car that has a new type of spring suspension, and I fully believe that this is going to do more to benefit the passenger car industry than any invention since the pneumatic tire. It has proved beyond a doubt that a passenger car can be built to hold the road and stand up at high speeds with a very much lighter construction than has ever been possible before. It has established the fact that a car weighing 1800 lb. can be driven at 60 miles per hr. with perfect safety and maximum comfort for the passengers, without the use of shock absorbers or snubbers. With such a car on the market and the above facts accepted by the public, there can be no doubt as to whether a car can be built lighter and more efficient with perfect roadability, than the cars that are on the market at the present time.

A New Spring Suspension

This spring suspension will be known as the three-point cantilever spring, and the cars using it will have a certain wheelbase and a longer spring base. To explain this more fully the car that I speak of has a 100-in. wheelbase, with a 130-in. spring base. The front springs are entirely forward of the front axle and the rear set entirely back of the rear one. The extraordinary riding qualities of this type of spring suspension are not measured entirely by the difference between the length of the wheelbase and the spring base. It has an entirely new spring action which, in my opinion, will revolutionize passenger car construction.

I believe that the time is not far distant when each make and each type of passenger car will have to pass a Government inspection on the materials used in their construction and their treatment. This inspection to be based on roadability. For instance, a car designed to weigh 1800 lb. will not be allowed to travel above a certain number of miles per hour, unless the proper materials and heat treatment have been used in its construction; or, a car weighing 3000 lb. must have proper materials and heat treatment and travel at a safe speed for such construction. When this time arrives it will force all manufacturers to strengthen their metallurgical and inspection departments, which I believe to be two of the most important branches of the automobile industry.

Sleeve-Type and Poppet-Valve Engines

I firmly believe that the majority of the future passenger cars will be designed with four-cylinder engines of the sleeve type. This opinion is based upon the fact that the sleeve-type engine improves with age, and because a four-cylinder sleeve-type compares favorably with the six-cylinder poppet-valve engine as regards vibration. The former is sure to replace the overhead poppet-valve construction. The poppet valve is at a great disadvantage because the setting is always a compromise, whether the valves are set hot or cold. The expansion of the push rod and cylinder are in the same direction, but the walking beam reverses this condition, consequently if the valves are set right when cold, they are not right under any other condition. This same criticism applies if they are set while hot. The only thing that recommends the overhead type valve is the small combustion chamber, which increases efficiency. The sleeve type is equal in this respect.

The lubricating difficulties of the overhead mechanism are also very serious. The combination of the difficulties of valve setting and lubrication makes it practically impossible to insure quietness. This mechanism is also at a disadvantage because of the constantly increasing inefficiency, due to the fact that the valve seating becomes gradually poorer from the time the valves are ground until they are reground. I am making no comparison with the T-head or L-head poppet valves for the reason that I do not believe it is necessary to consider anything but the most efficient types. There can be no great future for the eight-cylinder engine because of cross vibration. There will be no large market for the twelve-cylinder type because of its weight, cost and inefficiency.

Appearance and Comfort

The efficient car will be at a very great disadvantage if it lacks an attractive appearance and comfort. Extreme simplicity of the chassis is necessary to reduce the weight sufficiently to allow the use of solid, substantial sheet metal work on the fenders, mud guards and body without increasing the total car weight beyond what it should be.

The car should be low enough in appearance to meet public demand, but great care should be taken not to get the center of gravity too low. In other words the ideal car should have as high a center of gravity as possible, without interfering with appearance.

The efficient car even with good appearance will be at a great disadvantage if lacking in comfort. The proper height and angle of seats with a wheelbase of sufficient length to permit a wide door design are also essential.

To sum the whole matter up, the future passenger car will be valued in proportion to its efficiency and appearance, which means the minimum vibration and weight, consistent with perfection of roadability. This weight in all cases should be light enough to permit the use of tires 4 in. or under. The diameter of the tire is mentioned here because of the necessity of having a tire small enough to pass through ruts, without wedging, on cross-country runs.

[1] Chief engineer, Willys-Overland Co., Toledo, Ohio.

The Automotive Industry and the Motor Transport Corps

By Lieut.-Col. B. F. Miller[1] (*Member*)

Semi-Annual Meeting Paper

THE future policy of the Motor Transport Corps in regard to its relations with manufacturers and automotive engineers depends on what the future military policy of the country will be, and this policy will be determined by Congress. The Motor Transport Corps is a temporary organization created under the Overman Act, and whether or not it will remain a separate corps is uncertain. In the bill for an army of 509,000 men submitted to the last Congress, it was recommended that a Motor Transport Corps be created, and this provided for 21,819 officers and men for peace-strength requirements of the Motor Transport Corps. It may be definitely stated, however, that regardless of whether a small army or a large army is to be maintained, or whether a Motor Transport Corps is created or a return made to the pre-war system of dividing control of motor vehicles among the Quartermaster Corps, Signal Corps, Medical Department, Ordnance Department and others, the motor vehicle for military use has come to stay and will rapidly replace the animal-drawn vehicles, just as is the case for commercial use.

Motor Transport Corps Development

As is well known to the motor-vehicle industry, when the Villa raid occurred at Columbus, N. Mex., in March, 1916, the American Army had practically no motor vehicles and had no personnel qualified for their operation and maintenance. Had half a dozen motor transport companies been available near Columbus or at El Paso when the raid occurred, they could have been utilized for rapid transport of the pursuing troops, and it is believed that in this event the punitive expedition would have ended successfully in a short time, as it is entirely practicable to transport men, guns and animals by trucks. We are fully prepared in the matter of motor vehicles for border use now, and in any future expeditions they will play an important part. One of the developments of the present war was the use of motor vehicles for rapid transport of combat organizations from rest and training areas to the threatened points at the front for repelling German drives. Trucks were first used for this purpose at Verdun by the French Government and afterward in the March, May and July, 1918, and other drives. The following statement was made by a chief of staff of one of the fighting divisions: "It would pay to use the truck trains to move the foot troops and the supplies, making two or even three trips while the animal-drawn column is covering the same distance, in this case 70 miles."

The importance of motor vehicles for military purposes has been fully demonstrated in this war. That they will become increasingly important is certain. The number of motor vehicles required for one army at war strength under the old tables of organization was, in round numbers, approximately 6000 motor cars, 5000 ambulances, 4500 ¾ to 1 ton or Class AA trucks; 10,700 1½ to 2 ton or Class A trucks; 19,000 3 to 5 ton or Class B trucks; 11,000 four-wheel-drive or Class T trucks; 21,000 motorcycles and 7000 bicycles. The number required for the proposed peace-strength army with increased motorization is, in round numbers, approximately 4200 motor cars, 1673 ambulances, 4000 ¾ to 1 ton or Class AA trucks; 3300 1½ to 2 ton or Class A trucks; 8000 3 to 5 ton or Class B trucks; 3700 four-wheel-drive or Class T trucks, 10,000 motorcycles, 4000 trailers of various types and 3400 tractors, or approximately 47,000 motor vehicles of different kinds. There are on hand sufficient motor vehicles to fill the most of the peace-time requirements. Shortages in this will be covered by bringing the required number back from the A. E. F.

Disposal of Surplus Motor Vehicles

At the date of the signing of the armistice, the Motor Transport Corps recommended that surplus motor vehicles in this country be turned over to the Post Office Department and other Government bureaus, and that the motor vehicles in France be disposed of to European buyers, and this procedure is in general being carried out. This plan was also recommended by the Motors Division of the Quartermaster General's Office in January, 1918, and was approved by Mr. Girl, who, in commenting on the plan, stated: "In other words, the trucks now purchased should be kept for Army purposes, the building of good roads, transcontinental highways, Gulf to Great Lakes highways, etc. We should develop, if possible, highway connections through Mexico to South America, and all the trucks the Government might own could be utilized to get together on such work."

In making the recommendation regarding the disposition of surplus motor vehicles, the Motor Transport Corps and the Motors Division of the Quartermaster General's Office had in mind that modern warfare is mainly a big industrial, engineering and transportation undertaking, and aside from material for offense and defense uses the same methods, appliances and tools that have proved to be efficient in commercial life. For this reason it will be readily seen that most of these instruments of war can, with little or no modification, be used commercially in time of peace. It was considered that there is nothing so important in preparation for future defense as the development of transportation and of good roads, and of prosperity which results chiefly from a combination of good roads and efficient and adequate transportation facilities.

It was believed that from an economic point of view it is preferable to sell motor vehicles to France, even if only at a nominal price, to be used in rebuilding and developing that country, because, as stated previously, the most important factors in producing prosperity are efficient and sufficient transportation facilities and good roads. It was also believed that to prevent industrial and consequent labor troubles following most wars, it was best to make plans for future prosperity and development in this country; and, due to the fact that the automotive

[1]Motor Transport Corps, Washington.

industry was almost 100 per cent on war work, the Motor Transport Corps is naturally most interested in the development of that industry. It is believed that by avoiding any recommendation causing the dumping on the market of surplus motor vehicles and by creating the demand for motor vehicles and good roads development, the Motor Transport Corps could best assist in this. The recommendation that vehicles in Europe be sold there and the surplus in this country be disposed of to the Post Office and other Government bureaus and to communities for development of good roads, was considered the best way of accomplishing this. In the development of these good roads to provide for future military needs in case the era of universal peace has not yet arrived, it is believed that properly located military roads are an important means of defense and that efficient and sufficient motor transportation to use these roads for moving troops, supplies and artillery is very important.

It is also highly important that adequate means of transportation be provided for hauling food from agricultural centers, troops from centers of population and munitions from manufacturing centers. That our railroads, canals and steamboat lines are not adequate was conclusively proved during the fall and winter of 1917 and 1918. That the use of motor vehicles is necessary, feasible and proper has been proved by the use of the

Name of Unit	Number of Units	Brigadier-Generals	Colonels	Lieutenant-Colonels	Majors	Captains	First Lieutenants	Second Lieutenants	Total Commissioned	Sergeants, Senior Grade	Quartermaster Sergeants, Motor Transport Corps	Sergeants, First Class	First Sergeants	Sergeants	Corporals	Cooks	Privates, First Class	Privates	Total Enlisted	Aggregate
Office Chief of Motor Transport Corps	1	1	4	6	10	20	10	24	75	...	4	20	...	90	35	2	50	43	246	321
Designers and Engineers	1	..	3	6	8	16	9	10	52	4	2	25	1	30	30	2	10	10	114	166
Schools	1	..	1	2	7	20	18	67	115	8	12	48	8	128	80	24	30	300	638	753
Department Motor Transport Officers	9	..	1	5	6	10	10	10	42	2	..	20	...	10	20	..	10	....	60	102
District Motor Transport Officers	9	..	4	6	13	20	19	42	104	...	..	121	...	315	33	24	64	37	594	698
Total overhead	...	1	13	25	44	86	66	153	388	14	18	234	9	573	198	52	164	390	1652	2040
Motor Transport Companies	97	..	..	..	..	...	97	97	194	...	..	..	97	679	3298	194	970	2328	7566	7760
Motorcycle Companies	15	..	..	..	..	...	15	15	30	...	..	..	15	75	15	15	450	....	570	600
Headquarters Motor Commands	26	..	..	..	..	28	56	28	112	...	..	84	...	56	112	..	56	....	308	420
Service Parks	273	..	..	..	..	...	273	..	273	...	..	2184	...	1638	1365	273	2730	1365	9555	9828
Repair Units	19	..	..	..	19	284	191	399	893	304	..	1615	304	6688	1235	608	8189	3743	22,686	23,579
Total repair and operations	...	..	..	..	19	312	632	539	1502	304	..	3883	416	9136	6025	1090	12,395	7436	40,685	42,187
Division Motor Transport Officers	24	..	..	..	24	48	24	24	120	...	..	24	...	72	24	..	24	96	240	360
Division Headquarters Motor Commands	72	..	..	..	..	72	144	72	288	...	..	216	...	144	288	..	144	....	792	1080
Division Motor Transport Companies	264	..	..	..	..	...	264	264	528	...	..	..	264	1848	8976	528	2640	6336	20,592	21,120
Division Motorcycle Companies	24	..	..	..	..	...	24	24	48	...	..	..	24	120	24	24	720	....	912	960
Attached to Division Sanitary Train	24	..	..	..	..	...	..	48	48	...	..	..	...	....	....	..	....	....	....	48
Total Division	...	..	..	..	24	120	456	432	1032	...	..	240	288	2184	9312	552	3528	6432	22,536	23,568
Corps Motor Transport Officers	5	..	..	5	..	10	5	5	25	...	..	5	...	15	5	..	10	15	50	75
Corps Headquarters Motor Commands	25	..	..	..	..	25	50	25	100	...	..	75	...	50	100	..	50	....	275	375
Corps Motor Transport Companies	95	..	..	..	..	...	95	95	190	...	..	..	95	665	3230	190	950	2280	7410	7600
Corps Motorcycle Companies	10	..	..	..	..	...	10	10	20	...	..	..	10	50	10	10	300	....	380	400
Attached to Corps Sanitary Train	5	..	..	..	..	...	..	10	10	...	..	..	...	....	....	..	....	....	....	10
Total corps	...	..	..	5	..	35	160	145	345	...	..	80	105	780	3345	200	1310	2295	8115	8460
Army Motor Transport Officers	1	..	1	..	1	5	2	6	15	...	2	3	...	6	3	..	8	10	32	47
Army Artillery Motor Transport Officers	1	..	..	1	..	3	..	3	7	...	..	1	...	4	2	..	2	5	14	21
Army Motor Transport Companies	75	..	..	..	..	...	75	75	150	...	..	..	75	525	2550	150	750	1800	5850	6000
Army Headquarters Motor Commands	20	..	..	..	..	20	40	20	80	...	..	60	...	40	80	..	40	....	220	300
Army Motorcycle Companies	4	..	..	..	..	...	4	4	8	...	..	..	4	20	4	4	120	....	152	160
Motor Repair Shop Truck Companies	...	..	..	..	..	4	32	4	40	...	..	204	...	152	136	24	248	120	884	924
Army Reserve Chauffeurs	1	..	..	..	..	1	1	2	4	...	..	..	...	....	100	..	200	100	400	404
Attached to Army Sanitary Train	1	..	..	..	..	...	..	2	2	...	..	..	...	....	....	..	....	....	....	2
Total army	...	..	1	1	1	33	154	116	306	...	2	268	79	747	2875	178	1368	2035	7552	7858
General Headquarters Motor Commands	10	..	..	..	..	10	20	10	40	...	..	30	...	20	40	..	20	....	110	150
General Headquarters Motor Transport Companies	39	..	..	..	..	...	39	39	78	...	..	..	39	273	1326	78	390	936	3042	3120
General Headquarters Motorcycle Companies	2	..	..	..	..	...	2	2	4	...	..	..	2	10	2	2	60	....	76	80
Total general headquarters	...	..	..	..	..	10	61	51	122	...	..	30	41	303	1368	80	470	936	3228	3350
Grand total, war strength	...	1	14	31	88	596	1529	1436	3695	318	20	4735	938	13,723	23,123	2152	19,235	19,524	83,768	87,463
Peace strength (Chart 2)	...	1	8	22	58	61	283	649	1082	170	15	849	419	4422	4958	943	4647	4314	20,737	21,819
Reserve strength (Chart 3)	...	..	6	9	30	535	1246	787	2613	148	5	3886	519	9301	18,165	1209	14,588	15,210	63,031	65,644

CHART 1, SHOWING MOTOR TRANSPORT PERSONNEL REQUIRED ON A WAR BASIS

	Number of Units	General Officers	Colonels	Lieutenant-Colonels	Majors	Captains	First Lieutenants	Second Lieutenants	Total Commissioned	Sergeants, Senior Grade Motor Transport Corps	Quartermaster Sergeants, Motor Transport Corps	Sergeants, First Class	First Sergeants	Sergeants	Corporals	Cooks	Privates, First Class	Privates	Total Enlisted	Aggregate
Office Chief of Motor Transport Corps	1	1	3	5	8	15	..	...	32	2	4	...	...	...	....	..	....	....	6	38
Designers and Engineers	1	..	1	2	3	6	9	10	31	4	2	25	1	30	30	2	10	10	114	145
Schools	1	..	1	1	4	10	12	30	58	4	8	40	4	75	75	24	25	150	405	463
Department Motor Transport Officers	9	..	..	4	5	9	9	9	36	...	...	18	...	9	18	..	9	....	54	90
District Motor Transport Officers	11	..	2	4	6	12	11	24	59	...	...	73	...	196	10	15	22	37	353	412
Total overhead		1	7	16	26	52	41	73	216	10	14	156	5	310	133	41	66	197	932	1148
Motor Transport Companies	97	..	..	..	..	..	..	97	97	...	...	..	97	679	1649	194	485	1164	4268	4365
Motorcycle Companies	7	..	..	..	..	..	..	7	7	...	...	..	7	35	7	7	196	....	252	259
Headquarters Motor Commands	28	..	..	..	..	..	28	28	56	...	...	56	...	28	56	..	28	....	168	224
Service Parks	100	..	..	..	..	..	100	...	100	...	...	400	...	300	300	100	500	200	1800	1900
Repair Units	10	..	..	..	10	..	40	170	220	160	...	10	160	1920	490	320	1800	1170	6030	6250
Total operations, repair, etc	..	..	..	..	10	..	168	302	480	160	...	466	264	2962	2502	621	3009	2534	12,518	12,998
Division Motor Transport Officers	21	..	..	..	21	..	21	21	63	..	...	21	...	21	21	..	21	42	126	189
Division Motor Transport Companies	105	..	..	..	..	..	..	105	105	...	...	..	105	735	1785	210	525	1260	4620	4725
Division Motorcycle Companies	21	..	..	..	..	..	..	21	21	...	...	..	21	105	21	21	588	....	756	777
Division Headquarters Motor Commands	42	..	..	..	..	..	42	42	84	...	...	84	..	42	84	..	42	....	252	336
Attached to Division Sanitary Trains	21	..	..	..	..	..	..	42	42	...	...	..	..	..	....	..	....	....	....	42
Total for divisions	..	..	..	..	21	..	63	231	315	...	...	105	126	903	1911	231	1176	1302	5754	6069
Corps Motor Transport Officers	5	..	..	5	..	5	..	5	15	...	...	5	...	5	5	..	5	10	30	45
Corps Motor Transport Companies	15	..	..	..	..	..	..	15	15	...	...	..	15	105	255	30	75	180	660	675
Corps Motorcycle Companies	5	..	..	..	..	..	..	5	5	...	...	..	5	25	5	5	140	....	180	185
Corps Headquarters Motor Commands	5	..	..	..	..	..	5	5	10	...	...	10	...	5	10	..	5	....	30	40
Total for corps	..	..	..	5	..	5	5	30	45	...	...	15	20	140	275	35	225	190	900	945
Army Motor Transport Officers	1	..	1	..	1	2	1	2	7	...	1	..	...	2	2	..	2	5	12	19
Army Artillery Motor Transport Officers	1	..	..	1	..	1	..	2	4	...	...	1	...	2	1	..	1	2	7	11
Army Repair Shop Truck Companies	1	..	..	..	..	1	4	4	9	...	...	104	...	76	80	8	124	48	440	449
Army Motor Transport Companies	3	..	..	..	..	..	..	3	3	...	...	..	3	21	51	6	15	36	132	135
Army Motorcycle Companies	1	..	..	..	..	..	..	1	1	...	...	..	1	5	1	1	28	....	36	37
Army Headquarters Motor Commands	1	..	..	..	..	..	1	1	2	...	...	2	...	1	2	..	1	....	6	8
Total army	..	..	1	1	1	4	6	13	26	...	1	107	4	107	137	15	171	91	633	659
Grand total	..	1	8	22	58	61	283	649	1082	170	15	849	419	4422	4958	943	4647	4314	20,737	21,819

CHART 2, SHOWING MOTOR TRANSPORT PERSONNEL REQUIRED FOR A PROPOSED PEACE ARMY OF 509,000 MEN

Army Motor Convoy Service for delivering trucks and supplies from various factories to the ports of embarkation under the most adverse conditions of cold and snow, which was made at the approximate cost of 6 cents per ton-mile, with a personnel untrained or partially trained in the operation of motor vehicles. This was also conclusively proved by the similar use of motor trucks for the economical and expeditious delivery of goods over long distances for commercial companies and by the delivery of passenger cars to dealers by driveaways from factories. All of these hauling propositions, including the Army Motor Convoy Service, were developed under suggestion and with the assistance of the Highways Transport Committee of the Council of National Defense.

That the location of military roads previously recommended will, with but few exceptions, coincide with the roads located for commercial purposes is evident and it is also very certain that the development of these good roads will cause numerous changes and improvements in motor vehicles for commercial use and it is highly desirable and important that military motor vehicles keep abreast of, or if possible in advance of, commercial development. As previously stated, vehicles are available for initial equipment of the proposed peace-time army with a small reserve. As this material becomes unserviceable and obsolete from year to year, it is proposed by the Motor Transport Corps to replace it by new and up-to-date vehicles and to turn over to the Post Office, Bureau of Public Roads and other Government bureaus the surplus and obsolete equipment. For this purpose a yearly appropriation by Congress will be necessary and it is hoped that sufficient funds will be appropriated to permit a complete turnover every 5 yr. Sufficient funds are provided in the present pending appropriation act to provide for all necessary development, operation and maintenance during the coming year.

The requirements for the peace-time army have already been stated. It is the opinion of the Motor Transport Corps that there is also required and should be designed and developed a type of vehicle suitable for replacing the mule and horse-drawn wagons. This vehicle should be capable of traveling at the same speed and over all roads where animals can be used. It is my opinion that a light cargo-carrying vehicle of the caterpillar type will be the solution of this problem. The Motor Transport Corps has tried out and tested several different types

but thus far none has been suitable. It is highly probable that the Ordnance Department may design a suitable vehicle for this purpose evolved from some of its artillery caterpillar tractors, in which case the Motor Transport Corps will recommend its standardization for cargo hauling.

Plan in Regard to Design and Development

I have given the types and numbers of motor vehicles required. How to keep them up-to-date in regard to design and development is a problem that the Motor Transport Corps cannot solve except with the advice and assistance of this Society. The cooperation of this Society with the War Department developed the present military motor vehicle equipment until it is far superior in design and performance to any possessed by our Allies or our enemies. Examination of the exhibit of German trucks now in this country will confirm this statement. For this reason, with the help of the S. A. E. and moderate appropriations from Congress for design and development work, we should be able to hold our superior position.

The Motor Transport Corps expects to accomplish this by maintaining an organization of designers and engineers in the office of the chief of the Corps, which will, under the supervision of the Advisory Board now composed of Messrs. Younger, Dunham and Church and Major Browne, keep in close touch with this Society and with manufacturers for handling tests of

Name of Unit	Number of Units (Reserve)	General Officers	Colonels	Lieutenant-Colonels	Majors	Captains	First Lieutenants	Second Lieutenants	Total Commissioned	Sergeants, Senior Grade, Motor Transport Corps	Quartermaster Sergeants Motor Transport Corps	Sergeants, First Class	First Sergeants	Sergeants	Corporals	Cooks	Privates, First Class	Privates	Total Enlisted	Aggregate
Office Chief Motor Transport Corps	0	..	1	1	2	5	10	24	43	...	...	20	..	90	35	2	50	43	240	283
Designers and Engineers	0	..	2	4	5	10	..	...	21	...	...	...	..	...	....	..	....	....	....	21
Schools	0	..	..	1	3	10	6	37	57	4	4	8	4	53	5	..	5	150	233	290
Department Motor Transport Officer	..	..	1	1	1	1	1	1	6	...	...	2	...	1	2	..	1	....	6	12
District Motor Transport Officers	0	..	2	2	7	8	8	18	45	...	...	48	...	119	23	9	42	....	241	286
Total overhead	..	..	6	9	18	34	25	80	172	4	4	78	4	263	65	11	98	193	720	892
Motor Transport Companies	0	..	..	..	..	..	97	...	97	...	...	..	...	..	1649	..	485	1164	3298	3395
Motorcycle Companies	8	..	..	..	..	..	15	8	23	...	...	..	8	40	8	8	254	....	318	341
Headquarters Motor Commands	..	..	..	..	..	28	28	...	56	...	...	28	...	28	56	..	28	....	140	196
Service Parks	173	..	..	..	..	..	173	...	173	...	...	1784	...	1338	1065	173	2230	1165	7755	7928
Repair Units	9	..	..	..	9	284	151	229	673	144	...	1605	144	4768	745	288	6389	2573	16,656	17,329
Total operation and repair, etc	..	..	..	..	9	312	464	237	1022	144	...	3417	152	6174	3523	469	9386	4902	28,167	29,189
General Headquarters — Headquarters Motor Commands	10	..	..	..	..	10	20	10	40	...	...	30	...	20	40	..	20	....	110	150
General Headquarters Motor Transport Companies	39	..	..	..	..	..	39	39	78	...	...	..	39	273	1326	78	390	936	3042	3120
General Headquarters Motorcycle Companies	2	..	..	..	..	..	2	2	4	...	...	..	2	10	2	2	60	....	76	80
Total general headquarters	..	..	..	..	..	10	61	51	122	...	...	30	41	303	1368	80	470	936	3228	3350
Division Motor Transport Officers	3	..	..	..	3	48	3	3	57	...	...	3	...	51	3	..	3	54	114	171
Division Motor Transport Companies	159	..	..	..	..	..	264	159	423	...	...	..	159	1113	7191	318	2115	5076	15,972	16,395
Division Motorcycle Companies	3	..	..	..	..	..	24	3	27	...	...	..	3	15	3	3	132	....	156	183
Division Headquarters Motor Commands	30	..	..	..	..	72	102	30	204	...	...	132	...	102	204	..	102	....	540	744
Attached to Division Sanitary Train	3	..	..	..	..	..	..	6	6	...	...	..	..	..	....	..	....	....	....	6
Total for division troops	..	..	..	..	3	120	393	201	717	...	...	135	162	1281	7401	321	2352	5130	16,782	17,499
Corps Motor Transport Officers	0	..	..	..	..	5	5	...	10	...	...	..	...	10	....	..	5	5	20	30
Corps Motor Transport Companies	80	..	..	..	..	..	95	80	175	...	...	..	80	560	2975	160	875	2100	6750	6925
Corps Motorcycle Companies	5	..	..	..	..	..	10	5	15	...	...	..	5	25	5	5	160	....	200	215
Corps Headquarters Motor Commands	20	..	..	..	..	25	45	20	90	...	...	65	...	45	90	..	45	....	245	335
Attached to Corps Sanitary Train	5	..	..	..	..	..	..	10	10	...	...	...	...	..	....	..	....	....	....	10
Total for corps troops	..	..	..	..	..	30	155	115	300	...	...	65	85	640	3070	165	1085	2105	7215	7515
Army Motor Transport Officers	..	..	..	..	..	3	1	4	8	...	1	3	...	4	1	..	6	5	20	28
Army Artillery Motor Transport Officers	..	..	..	..	..	2	..	1	3	...	...	...	...	2	1	..	1	3	7	10
Army Repair Shop Truck Companies	3	..	..	..	..	3	28	...	31	...	...	100	...	76	56	16	124	72	444	475
Army Motor Transport Companies	72	..	..	..	..	..	75	72	147	...	...	..	72	504	2499	144	735	1764	5718	5865
Army Motorcycle Companies	3	..	..	..	..	..	4	3	7	...	...	..	3	15	3	3	92	....	116	123
Army Headquarters Motor Commands	19	..	..	..	..	20	39	19	78	...	...	58	...	39	78	..	39	....	214	292
Army Reserve Chauffeurs	1	..	..	..	..	1	1	2	4	...	...	..	..	..	100	..	200	100	400	404
Attached to Army Sanitary Train	1	..	..	..	..	..	..	2	2	...	...	..	..	..	....	..	....	....	....	2
Total for army troops	..	..	..	..	..	29	148	103	280	...	1	161	75	640	2738	163	1197	1944	6919	7199
Grand total	..	..	6	9	30	535	1246	787	2613	148	5	3886	519	9301	18,165	1209	14,588	15,210	63,031	65,644

Chart 3, Showing Motor Transport Corps, Reserve Corps and National Guard Personnel Required to Bring the Proposed Peace-Time Army to War Strength

motor vehicles at the Bureau of Standards as well as with the motor vehicle needs of other Government bureaus. The equipment and personnel of the Motor Transport Corps for handling tests of motor vehicles are located at the Bureau of Standards, and by agreement made between the Bureau and the War Department, all of this is available for the use of that bureau for any work it desires in connection with tests of motor vehicles. The Bureau of Standards will make any tests for the War Department required in connection with design, manufacture and tests of motor vehicles and accessories with its own appliances. This is a very satisfactory and time-saving arrangement.

The organization and personnel recommended for the designers and engineers was prepared by Mr. Younger while he was in charge. For the proposed peace-time army, including laboratory and motor vehicle testing personnel, it consists of 31 officers and 114 enlisted men of various grades. It is realized that with regular army salaries and prospects in time of peace, it will be impossible to induce any of the leading automobile designers to accept army positions, and it is therefore proposed that the Motor Transport Corps do only the detail work laid out. To obtain the services of these men in an advisory and directing capacity, it is proposed to maintain an officers' reserve corps in addition to the Advisory Board. The proposed peace strength for designers and engineers is thirty-nine officers. For war strength fifty-two officers are required, and the difference of twenty-one officers is recommended for the reserve corps, these to be selected from such of the leading designers and automotive engineers of the country as can be induced to accept the reserve commissions. These reserve officers are to be called into service from time to time for a few days each year to solve the design and engineering problems of the Motor Transport Corps and other Government departments, when the latter desire it, and the Motor Transport Corps designers and engineers will work out the details. This proposed reserve personnel consists of two colonels, four lieutenant-colonels, five majors and ten captains. While the personnel will be called into service for the period of the war or an emergency when the Army is mobilized, it is also proposed to maintain an additional reserve of officers taken from the leading engineers, designers and production experts, who will only be called into service for that period of time to serve in an advisory capacity. At present the law only authorizes the appointment of reserve officers to the grade of major and below, but it is believed and hoped that Congress will remedy this.

S. A. E. Assistance Requested

The Motor Transport Corps requests suggestions from this Society as to the make-up and organization of proper committees and sub-committees of this personnel. Each of these committees is to work in close touch with corresponding committees of this Society and with representatives of the manufacturers who will be asked to furnish engineers and production experts to give additional technical advice and assistance when required. In selecting men for these reserve commissions and the formation of an advisory organization, it should be borne in mind that the following motor vehicles and facilities are designed by the Motor Transport Corps: motor cars, motor trucks, trailers, wheeled tractors, motorcycles, bicycles, parts and accessories, machine shop trucks, garage equipment and other motor vehicle repair facilities. The Motor Transport Corps proposes to follow its policy in regard to standardization and reduction in number of makes and types of vehicle in so far as this is possible. This ideal policy was announced by Colonel Orton at the Annual Meeting in February last at New York City and has not been changed. It is proposed to keep production plans up to date at all times and a proper amount of tools and fixtures available so that in emergencies standard vehicles can be put into production rapidly. Until such time as the ideal policy is practicable it will be required that in sudden emergencies we use commercial types until standard production commences.

The following chassis models will be required: Trucks, Class B, 3 to 5 tons; Class A, 1½ to 2 tons; Class AA, ¾ to 1 ton; Class T, 3-ton four-wheel-drive, and possibly a 1½ to 2 ton type of four-wheel-drive, and when properly designed and developed, a cargo-carrying vehicle of the track-laying type. Mr. Younger believes this should be of 4-tons capacity. I think we should have one somewhere between 1½ and 2½ tons capacity.

A medium and also a heavy motor car are required, and a standard type of motorcycle, based on requirements determined by the experience of the present war, should be developed, as well as a standard type of military bicycle. The present authorized trailers should be retained and experimental work continued to improve their operation. The present trailer drawbars and pintle hooks are not completely satisfactory, and new and improved designs should be worked out. This is now being done by a sub-committee of the Truck Standards Division. Work will be continued on the specifications for tires and accessories in accordance with commercial development. Experimental work in conjunction with the Bureau of Standards in regard to fuels, materials, tires and accessories will be continued. Specifications and designs for mobile and stationary shops for performing service repairs, overhauling and rebuilding must be kept up to date. In connection with the repair question, it is believed this is of the utmost importance for military motor vehicles, because the operating conditions are severe and the personnel is sometimes untrained and inexperienced. The Motor Transport Corps has at present satisfactory designs and layouts for the various kinds of shop enumerated.

Spare Parts Problem

There is one vexatious unsolved problem that has been the bugbear of military users of motor vehicles during the present war both in the A. E. F. and in this country, and that is the lack of an efficient and economical system of spare parts supply. There have been millions of dollars expended for spare parts, and it is believed more money than was necessary has been invested in these parts, so it is my opinion that the fault lies in the system or lack of system. The Motor Transport Corps therefore requests the assistance of this Society and of the motor vehicle industry in general in solving this difficult and important problem. I think the solution lies in the preparation of spare parts lists or allowance tables. I believe that these lists or tables should show stocks which ought to be carried and replacements required under ordinary conditions for, first, ordinary repairs and adjustments made by the chauffeurs; second, for service repairs; third, for overhaul, and, fourth, for stocks required in rebuilding. Several arbitrary numbers of vehicles such as 1, 10 or 100 may be selected, or any other numbers deemed suitable by the S. A. E. The records of our maintenance and statistical branches, the A. E. F. records and experience tables and all knowledge

gained in the war would be made available to a committee appointed by this Society. It is true that the parts for different makes of the same type of vehicle are not the same, but there is enough similarity so that the best type of vehicle can be selected and a standardized ideal list prepared. It is believed these standardized lists or allowance tables will prove invaluable to the Motor Transport Corps and others as well as to the motor vehicle trade. Makers of various units could prepare the lists for the units they furnish and sub-committees could thus divide up the work. These lists or tables should be prepared to hold good for a certain period under ordinary conditions or could be prepared on a maximum and minimum stock allowance basis with a danger point for reordering. My recommendation is that the lists be prepared for the motor vehicles adopted as standard for military use. It is believed that by establishing a standard maintenance table for motor vehicles, its preparation and use will encourage the application of engineering ability to the maintenance of trucks and will improve their design by giving more maintenance information to the engineers representing manufacturers, and it will enable the value of S. A. E. Standards to be studied when in actual use.

Different types of design will show their adaptability to ordinary commercial service and a definite basis will be had for determining the operating costs of motor trucks. Thus far these costs have been mainly empirical and depend largely upon the spare parts required, since the maintenance labor expense is to a considerable extent a function of the cost of the parts. It is realized that the detail work involved in the preparation of these maintenance lists would be enormous, and this request would be considered too much of an imposition on the S. A. E. and manufacturers if it were not for the fact that the Motor Transport Corps has, to a large extent, completed the preliminary work, has on hand practically complete information for the making of the tables and is willing to submit the data and take the time to get these data into working form. It is understood that in the A. E. F., Major Mackie of the Motor Transport Corps is preparing complete experience tables based on data available from A. E. F. repair records. What is requested of this Society and the manufacturers is that the necessary technical advice and assistance be furnished so as to make these maintenance lists authoritative and workable, as it is realized the Motor Transport Corps has not the necessary technical personnel and ability to do this alone and unaided.

Training Plans for Time of Peace

The Motor Transport Corps has distributed geographically several large repair shops suitable for performing overhauling and rebuilding work. These shops were planned by Mr. Randles of the Foote-Burt Co., and are laid out so that by using the shop manual, which gives detailed shop procedure, a few officers and non-commissioned men qualified in shop work can, with untrained and inexpert personnel, turn out good rebuilding jobs. The Motor Transport Corps will make each one of these shops, of which there are four at present, into a school for training and developing mechanics for the various motorized organizations and at the same time perform the necessary overhauling and rebuilding work required for Army motor vehicles.

The courses are laid out so that the recruit enters as a laborer and passes through the various departments, and if he makes good is graduated as an all-around service station repairman. Others who specialize in one department are graduated as machine tool operators, carbureter mechanics, welders, etc., according to their specialties. There will also be a school for operating men such as chauffeurs, motorcycle drivers, etc., where the recruits will be given a standardized course for filling positions in operating organizations such as motor transport companies, motorcycle companies and headquarters motor commands. The graduates of the shop courses become mechanics in the repair units and service park units. Men who do not prove suitable in shopwork are given a course as chauffeurs or motorcycle drivers and are transferred to line organizations requiring these men.

It is proposed by the Motor Transport Corps to give each man who has completed his enlistment a definite commercial vocational rating, which is to be based on his ability as determined by examination and trade test. The Motor Transport Corps will endeavor to place men who have completed their enlistment with the automobile manufacturers and commercial motor vehicle users in accordance with the capabilities of each man. It is believed that if the plan is carefully carried out, in addition to providing men trained as soldiers and motor vehicle operators and repairmen, it will also prove of benefit to the automotive industry. In order that the training and development may be suitable and kept up to date, it is requested that this Society appoint a committee who are technically qualified in these matters to advise and assist the Motor Transport Corps in making these courses thorough, technically correct and up to date.

Motor Transport Corps Reserve

I have already given you the number of designers and engineers required for the Motor Transport Corps reserve. In addition, there are others who will be required for other administrative, operating and repair organizations. Chart 1 shows the personnel required for war strength, and it will be noted that there is a total of 3695 officers and 87,463 enlisted men. The next chart shows the Motor Transport Corps personnel proposed for the peace army of 509,000 men, with 1082 officers and 20,737 enlisted men. The last chart shows the reserve organizations and personnel required to bring the peace strength of the Motor Transport Corps up to war strength. This reserve amounts to 2613 officers and 63,031 enlisted men. It is believed that the automotive industry is most interested in the motor transport organizations of the Army and for this reason most of the Motor Transport Corps reserve personnel and reserve units should come from that industry. For example, there are required nine reserve repair units to be used for operating, overhauling and rebuilding shops, spare parts depots and similar units. A large manufacturer could furnish the officers and personnel for one or more of these repair units which are to be organized in time of peace from qualified employes who could be so picked by the manufacturer that in time of war or emergency it could be called to active duty without greatly inconveniencing the factory work. The method of having a complete military unit come from one commercial organization would also make for efficiency, morale and esprit and would cause a friendly rivalry between manufacturers maintaining similar units. The 173 service park units, which make service repairs, could be organized at smaller manufacturing organizations, service stations, large garages, branch houses and the like. The operating organizations, which are motor transport companies, motorcycle companies and headquarters motor commands, and also the administrative reserve personnel

required for schools and department and district motor transport officers' staffs, could be organized to a certain extent from other portions of the motor industry and trade. If the proposed plans are approved by Congress and the necessary legislation enacted, it is believed that this Society and the automotive industry can be of great benefit and assistance to the Motor Transport Corps in organizing, placing and obtaining personnel for forming the reserve organizations.

Without doubt many of you have learned through relatives, friends or employes in the service that there have been in the service a great number of men who through no fault of their own but rather through lack of a proper system of preparation have been square pegs in round holes. We may never have another war; that phrase was more familiar 10 yr. ago than now, but it will certainly do no harm and it would seem to be good business to make such preparations that we need not repeat the mistakes of this war should any future emergency require the mobilization of our Army. We should certainly take such precautions that our expert automobile men and mechanics will not be put to work issuing beans and running butcher shops while expert butchers and bakers are wasting their talents in operating and repairing motor trucks.

Summary

The use of motor transport is bound to increase in any future military operations. It is recognized that the efficiency of this transport will depend upon the assistance that can be received from the industry. This Society and its members can be of service both to the nation and to the industry by giving this assistance freely. Their cooperation is requested and desired in all work to be conducted by the Motor Transport Corps. It is intended in the future, as in the past, to give the industry the benefit of any experimental work or any other technical activity of the Motor Transport Corps. The German trucks recently received in this country are to be studied with this purpose in view, and it is proposed to put these trucks into a permanent exhibit so that they will be available for examination and study by the industry. We have also requested that at least one of each type of truck used by our Allies be shipped home so that we can add them to the exhibit.

The arrangements now made with the Bureau of Standards will be helpful in establishing requirements for materials, tires, fuels and other motor vehicle supplies. The maintenance phases of automotive engineering can be developed through the preparation of standardized ideal allowance lists of spare parts. Maintenance engineering has been practised effectively in England but has never received proper consideration in this country. Anyone who has seen the British Motor Transport in Belgium and in France will testify that the condition of the British Army trucks showed the result of the maintenance engineering.

The immense mass of data already collected by the Motor Transport Corps will be available for study by the Society and by the industry, and I believe will prove a considerable factor in the improvement of designs. Finally, the training courses to be carried on in Motor Transport Corps shops and schools will, I believe, benefit the manufacturers as well as the other branches of the industry. One of the greatest problems of the manufacturer and of the owner of motor vehicles is to see that these vehicles receive proper service. Men graduating from the Motor Transport Corps training courses will, upon the expiration of their enlistment, be available for positions in local service organizations or in the factories. It is believed that in the course of a few years these men will exert a marked influence for good on industrial and labor conditions when the marked antipathy the discharged soldiers and sailors feel toward the radical agitators who advocated the overthrow of law and order by violence in recent disturbances is considered. Military discipline and training are of great assistance in making law-abiding, patriotic citizens. Cooperation of all the members of the Society of Automotive Engineers is requested so that these men may be trained to be of both military and industrial value. I have stated what the Motor Transport Corps requests and asks from this Society and the automotive industry in carrying out a policy that it believes to be ideal. It is but fair that this Society and the industry should have a full opportunity to make requests in return. It is therefore suggested and asked that this Society or any member thereof or of the industry, after consideration of the announced policy of the Motor Transport Corps and its proposed relations with the S. A. E. and the automotive industry, make any requests or suggestions with a view to their own benefit. These should be sent to the Chief of the Motor Transport Corps, Washington, where they will receive prompt action.

The points of contact between the Motor Transport Corps and the industry are such as to indicate that working together will prove of much mutual benefit. The Society has shown its patriotism during the war, and the Corps looks forward to its assistance in time of peace. With this freely given, military motor vehicle equipment can be developed and kept abreast of current practice at all times. It is believed that it will prove to be both desirable and profitable to the country to carry out this program regardless of the possibility that we may never have another war.

A Constructive Labor Program[1]

By Prof. T. N. Carver (*Non-Member*)

THE subject, as announced, is a constructive labor problem. The word "constructive" probably carries its own meaning. It is designed to distinguish this program from various destructive programs based upon force or class hatred. This is a peaceful program—one that can be carried out without force or authority, and on the basis of voluntary agreement among free citizens. It can be carried out without sacrificing anything that can properly be called liberty.

There has been a tendency in recent years, especially in so-called "reform circles," to disparage liberty, at least in comparison with prosperity. It seems to have been too frequently assumed that there is some sort of irreconcilable conflict between the idea of liberty and the idea of prosperity. This assumed conflict is well illustrated in the old fable of the wolf and the dog. According to this fable, a lean and hungry wolf fell into conversation with a sleek and well-fed house dog. The wolf inquired how it was that the dog was always so well fed. The dog explained what an easy life he led, merely guarding his master's house. But the wolf noticed that the dog wore a collar and, upon learning that he had to be chained, decided that, as for himself, he would rather be free and hungry than chained and well fed. In this story it appeared that each had to take his choice. The wolf could not have both liberty and prosperity nor the dog prosperity and liberty.

The choice in such a case will always depend somewhat upon the spirit of the individual. Some will prefer liberty, others prosperity. Likewise, they who assume that in modern industrial society there is no such thing as having both at the same time will be forced to make a choice. Those who prefer prosperity to liberty will be inclined to speak disparagingly of liberty and will be willing to accept a social order which guarantees them prosperity, even though it deprives them of liberty. Others, with a different spirit, will speak in praise of liberty and be willing to accept a social order which assures them of liberty even though they have to sacrifice prosperity. The constructive labor program which I am going to present involves no such choice as this. It is a program which will combine all the liberty which we now enjoy, with the prosperity for everybody which is now enjoyed by the well-to-do classes.

There have been so many centuries in which the laborer, particularly the unskilled laborer, has been at a disadvantage under the system of liberty, that many of us have come to think that he must necessarily always be at a disadvantage in a free society. That is to say, under the system of voluntary agreement among free citizens, sometimes called the system of free contract or free bargaining, he has been so uniformly at a disadvantage as to lead us to think that he must always be at a disadvantage under this system, and that therefore his only chance of prosperity is to do away with the system of liberty and substitute something else.

Nature of Labor and Capital

There is really nothing in the nature of labor which necessarily makes it sell at a low price; and there is nothing inherent in the nature of capital which gives the capitalist any advantage at all over the laborer in the process of free bargaining in the open market. Those who have anything to sell, whether it be labor or something else, can prosper under the system of voluntary agreement, provided what they have to sell is something which is generally wanted and provided it is not oversupplied. Those who have something of this kind to sell will have both prosperity and liberty; but those who have something to sell which is not generally wanted, or which is oversupplied, will have a hard time selling it. They may have liberty, but not prosperity. They may, therefore, be forgiven, for the time being, at least, if they feel that liberty is of no great advantage to them. The other class, which prospers under liberty, should not be too critical of the class which holds liberty in low esteem under the circumstances. If we can so balance the market as to make it possible for all classes to prosper equally by the method of voluntary agreement, we shall have created conditions under which all will probably place an equal value upon liberty.

To create such conditions as will enable all classes of laborers to prosper under the system of voluntary agreement or free bargaining, we must create conditions under which every laborer, whatever his class or occupation, can very easily and quickly find employment at high wages. This cannot be done for any occupation until men are scarce and hard to find in that occupation. When employers have to hunt for men, instead of men having to hunt for employers, we shall be in a fair way toward such a condition. Then no laborer will need to be unemployed, nor will he need to accept low wages to avoid unemployment. As a free bargainer in the open market, he will then be able to prosper. In short, he will have both liberty and prosperity.

Under such conditions we shall need very little of what is commonly called social legislation to protect the laborer. He will then be able to protect himself, because he will have the opportunity to select his own job and will have at least an equal voice in the dictation of terms. Under such conditions, the term "wage slavery" would have no meaning whatsoever, and no one would be able to use such a term with a straight face. When his employer is quite as anxious to retain his services, knowing that he will be hard to replace, as he is to retain his job, knowing that it will be easy to get another one, the employer will have no advantage whatsoever in bargaining in the free and open market. They can meet as free and equal citizens and make whatever arrangements are to their mutual advantage.

The Philosophy of Balance

Back of this program is the most constructive form of economic philosophy known to the present world. It may properly be called the philosophy of balance. Nearly every bad economic condition grows out of a bad balance or lack of balance among the economic factors. Every good economic condition is the result of a proper balance among the economic factors. This rather bald statement of principle can be supported by a multitude of illustrations. For example, a year ago this winter the cran-

[1]From an address at a forum for Harvard students.

berry growers on Cape Cod found it difficult to get good prices for cranberries. When other prices were rising, that of cranberries tended to fall. The reason was that both sugar and cranberries are needed to make a palatable dish. Sugar was high and hard to find in the winter of a year ago. Things were thrown out of balance by the scarcity of sugar; or, in other words, this scarcity of sugar made a superfluity of cranberries, not because more cranberries were grown than commonly but because fewer could be used. This was not due to any increasing dislike of cranberry sauce, but to the scarcity of the other necessary ingredient, namely, sugar. This is one among a multitude of illustrations of the necessity of balance and of the evil results of a lack of balance. Those cranberry growers who depended for their living on the sale of cranberries were impoverished by this lack of balance. They who had sugar to sell were prosperous.

This condition was not sufficient to condemn the method of free bargaining in the open market, or to justify a general campaign against the principle of liberty, and yet under this principle of liberty prosperity was unequally distributed as between the sugar producers and the cranberry growers. In other words, the remedy is to be found in restoring the balance between sugar and cranberries. Then both the sugar producers and the cranberry growers may prosper and still be free. To abolish the system of voluntary agreement and substitute some mechanical method of equalizing prosperity would not cure the evil at its source. The lack of balance was a physical fact. It would have existed under communism, socialism or Bolshevism, as truly as under freedom. It did not depend upon the institutional background. There was a measurable shortage of sugar, and this produced a measurable superabundance of cranberries in the time and place.

Every farmer knows that an unbalanced ration means poor nourishment, and that poor nourishment may result in other bad conditions. The lack of balance in the ration is also, where it exists, a physical and not primarily a social fact. The farmer will know perfectly well that the remedy is to balance the ration and not to try to doctor up the animal by some other method. He also knows that a lack of balance among the elements of plant food in the soil means a poor crop, and that the remedy is to restore the balance.

In case the cattle-feeders find that starch is abundant and protein scarce and hard to find, and that as a result they are feeding their cattle a surplus of starch and too little protein, this will actually affect, in a very important sense, the relative production of starch and protein. That is to say, the farmer would realize that he could not increase the rate of growth very much by adding starch to the ration, and that it would not retard the rate of growth very much if he were to reduce slightly the amount of starch in the ration. More starch more growth, would not be a correct formula. On the other hand, he would know that a little addition to the amount of protein in the ration would make a considerable addition to the growth of his animals, and a slight decrease in the amount of protein would make a considerable decrease in this growth. In other words, the formula, more protein more growth, would be the correct one. Or, in the case of an unbalanced soil, let us suppose that it contains too much nitrogen and too little potash. It is not necessary to the supposition that there should be absolutely too much nitrogen, but only that there should be more than sufficient to balance the supply of potash. In that case the relative productivity of nitrogen and potash would be affected in a very important sense. That is to say, putting more nitrogen in the soil would add little or nothing to the crop, whereas putting more potash in the soil would add materially to the crop. The formula, more nitrogen more crop, would not be true; the formula, more potash more crop, would be true. Whatever theory of causation the metaphysician might adopt, the facts assumed in these illustrations would furnish the farmer the kind of logic he would need to make a success of his business. It would be useless of tell him that nitrogen is just as productive as potash in the absolute sense. If he knew his business, and had a logical mind, he would refuse to buy nitrogen at any but the very lowest price. He would be willing to buy potash, even if it cost a high price.

The need of balance is found wherever two or more factors have to be combined in production. The results of a lack of balance are everywhere essentially the same. There must be a balance among all the factors of production in any industry, otherwise the same or similar results will follow as follow from a lack of balance in a ration or in the soil. The factor which is undersupplied is greatly needed, because the formula, a little more of this factor a great deal more product, is true; whereas, in the case of the factor which is oversupplied it is not true. This to the manager of an industry is sufficient reason for paying a high price for the one and a low price for the other. He would be unfit for the work of management if he did otherwise.

Not only must there be a balance of the factors of production in any given industry; there must be a balance of the factors of production in the whole nation. This involves, among other things, the idea of a balanced population. An unbalanced population would be a population in which there were too many people of one kind to work effectively with the existing number of people of the other kind. If, for example, there should be more hodcarriers than were needed to supply the masons, we should have as clear a case of lack of balance as though there were more nitrogen in the soil than was needed to balance the potash.

Result of an Oversupply

It would not throw any light on the situation where there were more hodcarriers than were needed to indulge in generalities. It would not add anything to our knowledge of the subject to remark that there could never be such a thing as an oversupply of labor, since labor produces everything. The very patent fact would be that there was an oversupply of hodcarriers and that hodcarriers alone cannot produce anything. The different kinds of labor needed in the building trades have to be balanced up, otherwise there will be too much of one kind of labor, with unemployment and low wages for it. The formula, more of this kind of labor more product, will not be true except in a very restricted sense, whereas it will be unqualifiedly true of the kind which is undersupplied. In the case of hodcarriers and brick masons, the obvious remedy would be to balance them up by increasing the number of brickmasons and decreasing the number of hodcarriers.

I was told, several years ago, of a Pittsburgh glass manufacturer who was thinking of adding a new branch to his business. This would have involved a considerable addition to his buildings and the employment afterward of several hundred additional men. Before he proceeded very far with his plan he found he should have to have two very highly-trained technical experts. These men

were not to be found in this country. He did not succeed in attracting any from Europe, even though he offered $22,000 a year for each. The result was that he did not build this addition to his plant and did not hire those extra men to run it. Here was an obvious case of a lack of balance in our population. If some university or technical school had foreseen the need, and trained the experts, that industry could have expanded, and it would have given employment to a considerable number of men. This educational institution would have been helping to preserve a balance in our population, which is, after all, the real function of educational institutions. It is their function to train men for the positions where more men are needed, and needed acutely, even though by so doing they reduce the number of other occupations where more men are not needed, or not needed very acutely.

It is my firm belief that if we go about it in the right way we can so balance up our population in a single generation as to make prosperity for everybody, and avoid all these extremes of wealth and poverty which we see around us. We can bring about such a balance between skilled and unskilled labor, between labor and managerial talent, and between all kinds of labor on the one hand and all kinds of machinery, tools and equipment on the other, as to distribute prosperity among all classes. This would effectually eliminate poverty by the removal of its principal source.

Before you go further, or accept my program, you must examine yourselves pretty closely and see whether in your heart of hearts you really want to eliminate poverty. You must bear in mind that you cannot eliminate poverty and still have cheap labor. Cheap labor is poverty and poverty is cheap labor. They cannot by any possibility be dissociated. If you think you must have cheap labor you are thinking that you must have poverty. If you are thinking that we must eliminate poverty, you are thinking that we must eliminate cheap labor. Let that be clearly understood. It can never be too much emphasized because it is now too easily overlooked. We shall never eliminate poverty until even unskilled labor is made so scarce and hard to find as to enable the unskilled laborer, without any help from the state or any philanthropic agency, to bargain in the free and open market for good wages.

By good wages we mean not simply what you may think you would be willing to pay, but what you think you yourself could live on comfortably if you had to—wages on which you think you could bring up a family and properly educate them. We shall never eliminate poverty until even the unskilled laborer who is willing to work can enjoy such an income as that. This is the system of economics sometimes called "bourgeois economics." But who are the "bourgeoise?" They are the men of peace, who have always been despised by the men of violence who prize their liberties. They are the men of peace who do not wish to be under any kind of authority or compulsion, whereas the men of violence prefer either to command or to receive commands. The man of peace, when he wants something, goes to some other man of peace, and, on the basis of voluntary agreement, tries to get the other man of peace to do for him what he wants to have done. This is the method of mutual agreement. It is the most efficient and economical method ever devised for carrying on industry. It is not an efficient method of managing an army. The army, apparently, can be efficiently managed only on the basis of authority, where every person either gives or receives orders, and nobody bargains for anything. Men who have grown up in a free society, where things are done by the method of voluntary agreement, and who have recently had some experience on the inside of a military organization, will have no difficulty in appreciating the difference. Not many of them, I believe, will care to make a permanent exchange of the system of voluntary agreement for the system of authority, and yet those who are in overcrowded occupations may find it impossible to prosper under the system of voluntary agreement. They may be willing to exchange this system for the system of authority unless they see a way of prospering under the bourgeois system. Their only possible chance of ever prospering is to balance up our population so that there will be no occupation more overcrowded than any other.

Overcrowded Occupations

By an overcrowded occupation I do not mean one in which it is difficult for the individual to prosper as much as he would like. Every one, I suppose, would like a larger income than he is getting, however large this may actually be. Since he finds it difficult to get a still larger income, he may say that his occupation is overcrowded. If a young lawyer finds it difficult to increase his income from $5,000 to $10,000, he is likely to feel that the legal profession is very much overcrowded, and since an unskilled laborer can, without great difficulty, get $600 a year, the lawyer may say that the unskilled laborer's occupation is not overcrowded. This, however, is a very misleading comparison. Occupations are not equally overcrowded until the incomes which may reasonably be anticipated approximate something like equality, taking into consideration, of course, the difference in the cost of education and of acquiring skill and experience.

A very good way of determining whether a given occupation is overcrowded or not is to determine first what a decent income would be; not what the average income has been in the past, but what you think, under the circumstances, it is necessary for a man to have to bring up his family in decency, efficiency and comfort, and to give them reasonable opportunities in the way of education. If you think that $5 or $10 a day, as the case may be, is the minimum on which any one can do this, then you need to see how hard or how easy it is for men in different occupations to get this income. Having this standard income in mind, you can test the matter by a sort of laboratory method. You can disguise yourself as a pick-and-shovel man and go out and seek a job at a standard wage, say $5 a day, keeping an accurate record of your experiences. Then disguise yourself as an employer seeking pick-and-shovel men, and offering them $5 a day, keeping, as before, an accurate record of your experiences. Then you can compare your two records and find out whether it was easier as a pick-and-shovel man to find an employer who will give you $5 than to find a pick-and-shovel man who will work for $5 a day. This will give you a pretty definite idea as to whether there is more overcrowding among pick-and-shovel men than among employers.

The question may be asked, "What are the methods by which this balancing up program may be facilitated?" First and foremost, of course, is our system of popular education. It is not worth preserving overnight except insofar as it helps to balance up or to train men to avoid the overcrowded and poorly-paid occupations and to enter the less crowded and better-paid occupations.

Back of our system of popular education, however, there should be democratic ideas and an entire absence of

traditional ideas as to what kind of education it is fit and proper for a young man to seek. Where aristocratic traditions prevail there is sometimes a great deal of opposition thrown in the way of the son of a laboring man who tries to improve his condition by fitting himself to do something better than his father did. Fortunately, in this country, we have little or nothing of that repressive spirit. A country with democratic ideals, where every man, whatever his family history, is encouraged to go as far with his education as his native ability will justify, and where educational opportunities are open to him, is a country in which the population ought normally to be fairly well balanced.

But why, it is asked, do we still have an unbalanced population in spite of our democratic ideals and our system of popular education? One reason is that before the war we had for several years been importing more than 1,000,000 unskilled laborers every year. While our democratic ideals and our system of popular education were thinning out the ranks of unskilled labor and training men for the higher positions we were unconsciously doing our utmost to vitiate this beneficent work by importing poverty by the millions.

If, instead of importing 1,000,000 unskilled laborers a year, we had been importing an equal number of employers a year, the case would have been reversed. That is to say, if the average immigrant, instead of crowding into the unskilled occupations, had crowded into the employing classes; if he had come with the knowledge, experience, skill and capital which would have enabled him to start a new bank, competing with the banks already established, a new factory or a new store to compete with those already running, this would have worked in the direction our educational institutions are working to increase the supply of the scarcer forms of talent to balance up our population and create increasing demands for unskilled labor without increasing its supply. But when, as a matter of fact, our immigration was of the opposite sort, it produced a contrary effect, and tended to maintain that unbalanced condition of our population which preserves poverty for the unskilled workers and prosperity for the people in those classes where numbers are scarce.

Restriction of Immigration

Obviously, then, as long as our immigrants are mainly of the unskilled working class, the most direct method of balancing up our population is restriction. It is for this reason that, beyond all question, the bill establishing a literacy test is the most far-reaching, constructive and beneficent piece of legislation that has been put through during the present administration, leaving out, of course, the war legislation. It does not in any way reduce the number of skilled laborers or employers who may come. It slightly reduces the number of ignorant and unskilled laborers who may come. It therefore tends to thin out the overcrowded ranks of unskilled labor, while promoting the filling up of the ranks of the skilled laborers and the employing classes.

But immigration from heaven has much the same effect as immigration from Europe on the balancing of our population. If the immigrants from heaven were mainly of the employing type, or if the educated and the talented had larger families than the ignorant and unskilled, this would help to balance up our population; but since the opposite is true, since the ignorant and unskilled seem to have larger families than the educated and the talented, this differential birth rate tends to produce an unbalanced population. I do not see just how legislation can correct this differential birth rate. Something, of course, can be done with the very lowest grades of our population, that is, the feebleminded and the palpably defective. They can be kept in comfortable institutions, segregated, and therefore prevented from multiplying. Beyond this, legislation probably cannot go. The difficulty must be reached, if it is reached at all, by education and moral improvement. If the ambition of the family builder can be developed until it becomes one of the dominant ambitions of every man, then the well-to-do will not sacrifice this ambition to others; then the poor and the ignorant will not spawn but will try to build families. This will result in larger families among the educated and the talented and smaller families than we now have among the ignorant and the unskilled.

A vigorous thrift campaign is also a necessary part of the balancing-up program. If we can persuade every individual whose income will permit it, to save and invest all that he can spare after providing for the health, strength and efficiency of himself and his family; that is, if we can persuade him to reduce the amount of luxuries and useless consumption and spend on tools, machinery, equipment, livestock and other productive agents the money which would otherwise be spent on luxuries, we shall so increase the material equipment of the country as to add materially to the demand for all kinds of labor. And if, at the same time, we are reducing the numbers of ignorant and unskilled laborers, this condition of an increase in the demand for labor and reduction of the supply will so improve the condition of all laborers as to equalize prosperity among all classes. This is the object and aim of all balancing-up programs. Under a rational and vigorous balancing-up program we can have as much equality as anybody wants and still have all the liberty that anybody now has. Here is a program so attractive as to make even socialism, or any other partial program which proposes to sacrifice liberty for prosperity or prosperity for liberty, look like a cheap and tawdry substitute.

ENGINEERING PROFESSION RESPONDED NOBLY

TO furnish the necessary organization of technical troops and specialists the original engineer arm of the United States Army was increased to 131.5 times its pre-war strength, and the proportion of engineer troops relative to the total forces was increased from 1.6 to 10.8 per cent. To accomplish this, a heavy demand was made upon the technical professions and upon the industries of this country. In filling this demand most necessary assistance was given by the engineering societies and journals, whose patriotic work demands the highest praise that can possibly be given to them by both Government officials and individual citizens.—Assistant Secretary of War Crowell.

The Annual Tractor Demonstration Dinner

THE S. A. E. Tractor Dinner, which has come to be one of the most important events held in connection with national tractor demonstrations, was held this year at the Hotel Lassen, Wichita, Kan., on the evening of July 17, the Thursday of National Tractor Demonstration week. The dinner was very well attended and was one of the most successful of its kind ever held. Practically every tractor company had at least one representative at the dinner, and a large number of parts and accessory makers were also well represented. In all, 272 persons were present, and the tent adjacent to the Hotel Lassen in which the dinner was served was very well filled.

Past-president Charles F. Kettering acted as toastmaster. He arrived in Wichita the day prior to the dinner, having come by the air route in a De Haviland plane from Dayton, Ohio, a distance of approximately 800 miles, in about 7 hr. flying time. The machine was piloted by Howard Reinhardt and flew at an altitude of about 4000 ft. during the greater part of the journey.

Chairman David Beecroft, in introducing Mr. Kettering, referred to him as a "super-farmer" who is greatly interested in the farm tractor and uses several of them on his own farm. In responding, Mr. Kettering referred to agriculture as the most fundamental of our industries, and stated that he believed the next hundred years would be known as the agricultural age in the history of this country. He predicted an enormous development of power farming and said the possibilities in this field are as yet virtually untouched. Mr. Kettering emphasized the fact that we are passing now into a new economic condition, that it is impossible to predict future conditions from pre-war experience and that we must now start from a new base line with a far broader viewpoint than has heretofore been general. He gave it as his personal view that we have almost reached a time when national demonstrations of the farm tractor will be unnecessary. He predicted that future demonstrations will be more local in character. Referring to his trip from Dayton, Mr. Kettering stated that this was not to be considered in any sense as a "stunt," but was undertaken chiefly to demonstrate the entire feasibility and economic practicability of long flights where saving in time is a prime requisite. To illustrate this fact, Mr. Kettering stated that he left Philadelphia for Dayton on Tuesday evening on a fast train due at St. Louis late on Wednesday afternoon. Arriving in Dayton early on Wednesday morning he took time to repack his grip and attend to one or two items of business, after which he went aboard his airplane. The flight was started about 9 a. m., and the plane alighted 7 hr. later in Wichita, over 300 miles west of St. Louis, before the train which Mr. Kettering left at Dayton had reached St. Louis!

On completion of his address Mr. Kettering introduced the Hon. Henry J. Allen, governor of the State of Kansas. Gov. Allen paid a high compliment to the accomplishments of automotive and agricultural engineers, laying stress upon the revolution they have worked in farming methods by providing power-driven implements and machinery for farm use. In this connection Gov. Allen told some of his own experiences as a boy on a farm to contrast present conditions with those under which he formerly worked. Gov. Allen then outlined in part the program for the benefit of the farmer and improvement of farming conditions which he hopes to put into effect during his administration.

The next speaker of the evening was E. J. Gittins, vice-president of the J. I. Case Threshing Machine Co., who emphasized the need of designing tractors in which practicability from the users' standpoint and quality are prime requisites. He stated that the tractor must be capable of adapting itself to a variety of work to be a good investment for the farmer. Mr. Gittins, who is chairman of the Demonstration Committee of the National Implement & Vehicle Association, gave it as his opinion that the national demonstration has served a very useful purpose.

The next speaker was John Fields, who is editor of *The Oklahoma Farmer* and an agriculturalist whose program of power farming has been productive of remarkable results in his home and adjacent states. Mr. Fields emphasized the need for study of local conditions and of adapting farm methods to these conditions to make farming profitable. He showed, for example, how great losses have resulted from attempting to grow in Kansas crops not suited to conditions existing there. He quoted statistics to show that Kaffir corn, which is much better suited to local conditions in Oklahoma and Kansas than is other corn, had produced an acre value 36 per cent greater than other varieties of corn. Mr. Fields said that it should not be forgotten that farming is a life as well as a business, and that the lack of educational facilities on the farm has been the cause of many farmers moving to the city. He stated further that bankers controlling farm credits must be convinced of the economic value of power farming devices and other similar farm improvements before sales of such devices could be expected in quantities. He believed that failure to recognize this fact had resulted in the loss of much business which might otherwise have been transacted.

The program was concluded by addresses by Prof. L. W. Chase of the University of Nebraska and Mr. Hale, who holds a position as county agent in the State of Kansas. Professor Chase presented charts to show the need for standardized tractor ratings and emphasized the fact that there is now a variation of 50 per cent in the ratings of various tractors having engines of the same speed and dimensions. Mr. Hale expressed himself as much in favor of local demonstrations which can easily be seen by farmers without taking much time for travel. He stated further that many tractor failures could be traced to lack of proper instruction and expressed the view that it is the duty of the tractor dealer to educate the farmer to use properly the tractor he sells.

During the dinner the members and guests were entertained and appeared to enjoy greatly vocal selections rendered by the quartet of the Wichita Rotary Club.

A more extended account of the talks which followed the Tractor Dinner will appear in the September issue of THE JOURNAL.

Steel Truck Wheels

By P. KLINGER [1] (*Member*)

SEMI-ANNUAL MEETING PAPER

PRIOR to 1914 the motor truck had become a recognized and important part of industrial life, but the trying and strenuous conditions of the past 4 yr. have done much to cause the general public to realize the tremendous importance of motor trucks, with a consequent demand for the service which they can render. Under war-time production demands, time-saving possibilities of fast motor-truck service were so well demonstrated that today trucks are operated under load and speed conditions that were formerly thought prohibitive. While recognizing that in the past the majority of trucks have been equipped with wooden wheels which as a whole gave good service, we believe the time is fast approaching when the results demanded in service will make imperative the substitution of steel wheels on medium and heavy-duty trucks, thus eliminating practically the last important truck unit made of wood. Nearly all truck engineers and manufacturers recognize this, but hesitate to adopt them, largely because a metal wheel is somewhat higher in first cost and also because some designs of metal wheels have not rendered the service expected. Just as the value of a motor truck lies in ability to perform economical service, and this economy is usually not dependent on first cost, so does the properly designed steel wheel ultimately prove itself to be a real economy.

WHAT IS REQUIRED IN DESIGN

The design must be such that vibrations resulting from road shocks are not concentrated at any one point but distributed over, or dissipated throughout, the entire wheel structure; otherwise metal fatigue eventually results. Materials having a low elastic limit are not suitable for truck wheels any more than malleable or wrought iron is for vehicle springs, as a successful metal wheel must have a certain degree of resiliency. Many of you have no doubt had experience with the early designs of built-up metal wheels and are well acquainted with the difficulties of loosened rivets and bolts, also with cracks developing in some types of cast disk and spoke wheels.

Various essential and fundamental metal casting principles have not been recognized in the design of some cast metal wheels, such as the fact that all steel or iron castings are composed of crystals which are formed as the metal cools and run as consistently as the fibers in wood. Just as the weak spots in wood are where the branches run out, so the weak spots in castings are found where right-angle joints occur. Crystals form regularly at right angles with the contour of the castings, and where sections meet at right angles two crystal formations join and there is a resulting line of weakness. To overcome this tendency heavy fillets have been used at intersections, but the added mass of metal usually causes shrink-holes and consequent weakness.

A hollow-spoke hollow-rim construction with a semi-flaring attachment to the rim is a partial recognition of this fundamental feature, but a full realization of it is attained only by the hollow-spoke wheel where the spokes join the rim in broad sweeping curves, giving an arch-like support to the rim, at the same time avoiding objectionable crystalline formation and placing the metal so that the high elastic quality of steel is utilized somewhat in the form of a spring instead of as a dead strut, as is the case of the straight spoke of either cruciform or U-section and also very largely with the hollow spoke with the semi-flaring connection to the rim. Some disk wheels have cracked around the hub as well as near the rim. When spoke wheels have cracked it has been almost invariably in the spoke near the rim or in the rim near the spoke, but this has not occurred in wheels having the broad flaring connection between the spoke and the rim.

METAL WHEELS IN SERVICE

Probably the companies having the best opportunity to follow up wheels in service are the London General Omnibus or the Fifth Avenue Coach Co., both of which use metal wheels exclusively. The latter's first steel wheels were imported from Switzerland, being hollow spoke and solid rim with a very slight radius where the spoke joins the rim, and a number of these cracked in the rim between the spokes. However, they were welded and are still in service. It also used solid Y-spoke wheels, which cracked in the spoke where the spread of the Y starts; however, it got 50,000 miles out of the wheels, which was stated to be greatly in excess of the wood-wheel service. This company has steel wheels which have been in service for over 2 yr. and have developed no cracks or any other imperfections. These wheels have a flaring connection between the spoke and the rim. That it recognizes the ultimate economy of steel wheels is evidenced by the following quotation from one of its letters:

> The standardization of steel wheels has effected considerable economy, and the company has never for one moment regretted the initial outlay.

It is of interest here to note that the coach wheels last referred to are of the integral-hub type and the company is getting exceptional tire mileage; in fact, in almost every case where exceptional tire mileage is obtained metal wheels are in use. The tire companies recognize this, although they will not be quoted to that effect, but some claim as high as 100,000 miles.

The principal reason for added mileage on metal wheels is the fact that they are absolutely round with perfect fit and set for tire. They provide a true rolling surface and also have superior radiating qualities.

To quote the experimental engineer of one of the large tire companies:

> A well-built wood wheel is pretty rigid, and a properly designed steel wheel will be fully as flexible as a properly designed wood wheel. We find the most troublesome offense is in the wheels which are out of round, and especially those in which the deviation from true round is localized in one place. A flat wheel is the result. Metal-base tires, either demountable or pressed

[1] Chief engineer, Dayton Steel Foundry Co., Dayton, Ohio.

on, always give trouble on such wheels. Inasmuch as steel wheels are made to very accurate dimensions and moreover retain their original size and shape, you can readily see that the tire people are anxious for the development of steel wheels.

A large fleet owner writes:

As to the accuracy of workmanship on wood wheels, this can be attained on new wheels but cannot be maintained owing to the shrinkage in dry weather and the swelling in wet. Turning the hose on the wheels every evening lessens the tendency of spokes to loosen.

A special investigation made among users and garages in six of the large cities of the country showed that many instances of wheel trouble never are reported to the manufacturer, being accepted as a necessary evil.

STRENGTH OF WOOD AND METAL WHEELS COMPARED

As to comparative strength the following table gives the results of tests made by a recognized testing bureau on wheels designed for the same truck using 36 by 5 front and 36 by 10 rear wheels.

WEIGHTS OF DIFFERENT METAL WHEELS

	36 by 5 Front	40 by 5 Dual	Set
Cast-Steel Hollow Flaring Spoke Integral-Hub Wheel	130	269	798
Hubless Type Metal Wheel with Hubs and Bolts	158	319	954
Pressed Steel Built-up Wheels	131	275	812
Wood Wheel with Hubs and Bolts	116	336	904

weight, the comparisons given above compiled from data furnished by users of the types listed should be noted.

With a smaller size, say 2-ton, the wood and metal weights are approximately the same, and with larger sizes, 5-ton and up, the comparative weights are more in favor of the integral-hub type cast-steel wheels. As to first cost the integral-hub metal wheel is no doubt in most cases higher than the wood wheel, but there is such a variation in design and cost of hub equipments that in some cases the integral-hub metal wheel shows a saving in first cost.

STRENGTH TESTS OF METAL WHEELS

36 by 5 *Front Wheels*

Type	Weight, lb.	Maximum Radial Load Applied, lb.	Deformation at Maximum Load, in.	Permanent Set at Maximum Load, in.	Ultimate Side Thrust Loading, lb.
Pressed Steel, Built-up	147	40,000	......	......	30,500
Malleable Iron	147	60,000	0.0677	0.0259	27,600
Cast Steel Disk	169	60,000	0.0359	0.0187	48,100
Cast Steel, Hollow Rim, Hollow Flaring Spoke	100	60,000	0.0645	0.0220	49,200
Wood	Front Wheels Not Tested				

36 by 10 *Rear Wheels*

Type	Weight, lb.	Maximum Radial Load Applied, lb.	Deformation at Maximum Load, in.	Permanent Set at Maximum Load, in.	Ultimate Side Thrust Loading, lb.
Pressed Steel, Built-up	341	75,000	0.4153	0.3425	43,200
Malleable Iron	266	100,000	0.1928	0.1180	42,500
Cast Steel Disk	268	100,000	0.0881	0.0261	75,500
Cast Steel, Hollow Rim, Hollow Flaring Spoke	286	100,000	0.0513	0.0113	101,000
Wood	252	60,000	0.1082	0.0336	43,700

It should be noted that the wood wheel was not loaded above 60,000 lb. as the speed of deformation indicated an approach to the yield point. The pressed steel built-up type front wheel yielded beyond the range of the instruments at 40,000-lb. loading, and the rear at 75,000-lb. loading required almost the extreme instrument range. The relatively slight permanent set and the great resistance to side-thrust in the case of the cast-steel wheels, and especially in the hollow full-flaring spoke type, should also be noted.

In June, 1918, a 3-ton Liberty truck equipped with hollow flaring spoke type steel wheels, and loaded to full capacity, was struck by a passenger train running at approximately 35 miles per hr., and the wheels were absolutely not injured, although the pressed-on tires of one rear wheel were forced ¾ in. sidewise at the bottom of wheel, the heavy rear axle was bent, the alloy-steel springs were torn in two and the body of truck completely demolished. This is cited as a real service test that proves the superior qualities of the integral hub, hollow, full-flaring spoke steel wheel under side swipe, as shown in the laboratory tests noted.

Leaving the question of strength and considering

For the large-size pneumatic truck tire equipment most of the tire companies favor metal wheels, and a number of different satisfactory types have already been made. So far as my knowledge goes these have not been given careful laboratory tests but have withstood strenuous service tests, such as driving at speeds as high as 45 miles per hr. on 3-ton trucks, and withstanding tire inflation by hydraulic presure as high as 390 lb. per sq. in. on a 44 by 10 cord tire. A metal wheel enables a demountable rim to be used with a wheel rim having an open slot for the valve stem, thus eliminating any lifting of the tire and rim when applying. The apparent increasing tendency to use some type of internal drive will do much to increase the metal wheel demand because of the better maintenance of gear mesh with the use of integral-hub metal wheels. Consistent co-operation between the foundryman and truck engineers has done and will continue to do much toward the satisfactory service to be realized from metal wheels, and the price question will be largely solved by standardization of designs with consequent quantity production.

Experiences with the A. E. F. and the Armistice Commission

By A. J. SLADE[1] (*Member*) SEMI-ANNUAL MEETING ADDRESS

YOU have all no doubt read many articles by the able war correspondents attached to the American forces in Europe extolling the virtues of our doughboys, not only as soldiers but also as reliable shock troops. These articles have none of them exaggerated in the smallest degree the wonderful adaptability of these soldiers, their esprit, persistence and cheerfulness under the most difficult conditions and surroundings, and to them is, of course, due to the very greatest extent the success of our part in the Allied operations which led to the successful termination of hostilities on Nov. 11. But supporting organizations contributed to the success of the combat troops and I shall first touch on one of the more prosaic but none the less essential arms of the service, namely, the motor transport service, and that includes not only the Motor Transport Corps, whose functions were largely confined to the supply of equipment and the operation and maintenance of repair facilities, but also the operating units in the combat divisions, which utilized this equipment at the front. You are familiar with the methods pursued in this country in the procurement, manufacture and delivery to shipping points of the motor transport equipment. One of the serious handicaps to the motor transport service in France was due to the inadequate shipping facilities, which apparently made it impossible during last summer, when the troop movements to France were extremely heavy, to ship abroad the necessary amount of motor transportation, although an adequate quantity of this equipment may have been accumulated on this side of the ocean, and as a result foreign purchases were made to as great an extent as motor vehicle production abroad permitted, and a number of the older divisions in the A. E. F. went through the war with foreign equipment, secured principally from the British.

RECEPTION AND DISTRIBUTION OF EQUIPMENT IN FRANCE

Six base ports in France were made available for the receipt of American material, these ports extending along the coast from Marseilles on the Mediterranean up to La Havre on the English Channel. On the arrival of a convoy of ships containing motor vehicles at any of these base ports, the vehicles were unloaded, and if they had been shipped on their own wheels were towed to what were known as reception parks for preparation for their journey across France. Vehicles which were disassembled and crated had to be reassembled and taken to the reception parks at which points all these vehicles were repaired if they had become damaged in shipment, carefully adjusted and held ready for issue. At the same time General Headquarters would be notified that a certain amount of tonnage capacity had been received and instructions would then be issued by it as to the organizations to which this equipment would be issued. In the great haste attendant upon getting divisions still in training ready to go into the line the instructions from General Headquarters were generally to furnish each division a certain total of truck tonnage capacity, regardless of makes or types or for what service the vehicles had been originally provided. This, of course, resulted in many divisions having a miscellaneous assortment of equipment, and while the motor transport officers of the armies endeavored and in some cases succeeded in effecting redistribution between divisions in the interest of uniformity, the lack of standardization of makes and types within an organization still existed to an extent which made the maintenance and supply problem from the rear complicated and difficult.

When instructions were issued for the delivery of vehicles from the base ports, in some cases the personnel from the organization to which the vehicles were consigned would come to the base port and take possession at that point. In other cases, it was necessary to organize emergency convoy companies to deliver the machines. The lack of convoy officers with previous experience in the operation of motor trucks, especially in train formation, and the inadequacy of enlisted personnel with driving experience resulted in these convoy journeys across France being attended with many mishaps, and it was unusual on the whole for trains to reach their destination intact. On account of the congestion of the railroads all these vehicles carried loads to destinations along their routes. It was customary for these convoys to receive a second repair and adjustment at overhaul parks in the advance section or in the zone of the armies before going into service with their divisions. These repair organizations were formed and equipped as best they might be with such personnel as could be secured from any available source; the buildings consisted sometimes of barracks or other suitable structures, but in most cases they were only temporary buildings erected by the Engineer Corps, though in many cases, especially at the base ports, they were constructed by the Motor Transport Corps personnel, which utilized packing cases or similar available material for the purpose. Tools and equipment for these organizations were secured wherever they could be found, purchases being made not only in France and England but also in Spain.

SERVICE IN COMBAT ORGANIZATIONS

The service of the vehicles in the combat organizations was, of course, difficult as there were no housing facilities and infrequent opportunities for washing. The officers and men of the motor trains were more often than not found to be with limited experience in handling large numbers of motor vehicles and the deterioration of our equipment was unfortunately much more rapid than in the French and English armies. These conditions emphasize the necessity for adequate advance preparation, especially in the matter of trained and experienced personnel, and the plans proposed by the Motor Transport Corps as outlined in the paper presented by Colonel Miller indicate that these conditions are fully realized and definite plans are contemplated for overcoming this

[1]Consulting engineer, New York City, and formerly a lieutenant-colonel in the Motor Transport Corps.

unfortunate condition before the next emergency arises.

Vehicles becoming wornout or disabled beyond repair by the mobile repair shops or other repair facilities with the armies would be shipped by rail to the main reconstruction shop at Verneuil, which was on the main line of the railroad operated by the American Railroad Transportation Corps between St. Nazaire, our principal port, and the Toul sector, which was in our principal zone of operation. In the many handlings of such disabled vehicles before they finally reached the reconstruction shops, removable parts such as magnetos and carbureters, of which there seemed to be a continued scarcity, were invariably appropriated, with the result that there was considerable difficulty in reconstructing and returning vehicles to service at the front, up to the time of the armistice and the number of unserviceable vehicles was increasing at a truly alarming rate. Thus the prospects for a winter campaign, if the war had continued, were not encouraging. It was, therefore, a great relief to the motor transport service that the news of the armistice was announced. After the armistice the cessation of troop movements overseas made possible very large shipments of motor equipment with the result that at the time I left France in the beginning of May there were many thousand vehicles accumulated which had not been put into service and which were causing quite a serious problem in regard to their ultimate disposition.

The Best Vehicle for Service

I have been frequently asked since my return what make or type of vehicle proved to be the best for military operation in the A. E. F. The British and French both used commercial models of their own manufacture, and in addition several makes of American trucks, and it is an interesting fact that many English and French motor transport officers, both operating and shop men, have mentioned one American make as being the most popular in the English army, and another American make as being the most popular in the French army. The reasons for this preference for American makes are believed to be the interchangeability of parts due to quantity production and the excellent service which was secured from the vehicles when handled with intelligence.

Our Army had at least four English makes and one Italian make in two models, in addition to the various American commercial models with which you are familiar as having been shipped abroad by the various Army corps, and with the standardized Class B truck, made up a total of about twenty-five makes. More experience was had with some of these than with others and statistical data have been secured by the engineering division in the A. E. F. since the armistice by sending out questionnaires and following up the replies, thereby securing expressions of opinion on the different equipment from all the organizations, large and small, which were using the different types of trucks and cars. When all these reports are assembled and analyzed, taking into consideration the qualifications, expert or otherwise, of those furnishing the opinions it will perhaps be possible to reach sound conclusions, but it was observed when the replies to the questionnaire began to come in that the less expert the qualifications of the critic the more positive were the opinions expressed. Although one of my responsibilities was to transmit to Washington criticisms and suggestions for the betterment of motor equipment when epidemics of failures of one kind or another developed, and although in connection with the necessary investigations of such matters I spent very considerable periods with combat organizations at the front, especially during offensive engagements, I am not satisfied that at the moment we have secured sufficiently accurate data upon which to base any definite conclusions.

I am fully satisfied, however, that with competent personnel and intelligent organization, most vehicles which have proved commercially successful in this country can be satisfactorily utilized as military vehicles, and I should like to emphasize again the suggestion which I made in connection with a paper presented to the Society 3 yr. ago giving an account of two experimental test runs with commercial vehicles in military convoy formation, namely, that the knowledge and experience in motor-truck operation of a competent personnel is of greater importance than the providing of highly refined equipment which cannot be utilized to its fullest advantage by inexperienced officers and drivers. I was greatly pleased that the President of the Society in his address at the opening of the meeting touched on the question of organization and operating engineering quoted in the following paragraphs, and it is sincerely to be hoped that publicity will be given to the fact that this Society has a place for operating and maintenance engineers as well as designing and manufacturing engineers.

> But the work of the automotive engineer is not finished but merely begun, when the machines are designed and built, whether they be motor trucks, tractors, aircraft or other vehicles. There is more need today for real engineering work in connection with the planning and organization of the operating end of automotive vehicles and machines than there is in connection with the design and construction of them, just as there are more engineers engaged in the operating and maintenance end of railroads than are engaged in the design and construction of locomotives and railroad cars.
>
> In the subdivision of automotive engineering work having to do with motor trucks, the real work of the engineer has hardly as yet been begun. True it is that motor trucks are being sold and are daily hauling thousands of tons of merchandise and general freight, but the careful study and collection of data for accurately predetermining the best operating equipment, organization and personnel to meet given conditions at a definitely predetermined cost has hardly been started. This single phase of automotive engineering presents more problems for the engineer to solve than would be needed if all of our records and data in railroad transportation engineering were suddenly swept away and it became necessary to reestablish such data immediately for the determination of proper freight rates.

The International Armistice Commission

Immediately after the signing of the armistice the organization known as the Permanent International Armistice Commission was organized by Marechal Foch through the headquarters of the four Allied armies operating on the Western Front. Before touching on the work of this commission I would like to refer to another point which many of my friends have brought up and which seems to have been running in the public mind in this country. Some seem to feel that the termination of the war by the signing of the armistice was unfortunate in that it prevented a decisive military victory which might have been obtained if war had continued. Marechal Foch has himself answered this criticism in an interview with a newspaper representative, which was quoted in a recent issue of *The Literary Digest*, a portion of which is as follows:

> He, Marechal Foch, talked first of those last days of the war, explaining the final position in which the

German armies found themselves. His reply to the German request for an armistice, that he would sign an armistice, but that nothing could keep him from going till he reached the Rhine, was cabled to this country some time ago, but it has added significance as it appears in its original connection in this interview. It is noticeable that the alternative to an armistice was to be an attack by twenty divisions in Lorraine on Nov. 14. "I should have taken Metz," declares Marechal Foch, to which an American reviewer might be excused for adding, "With American troops."

"War's like this," he said suddenly, seizing a pencil and a sheet of paper. "Here is an inclined plane. An attack is like this ball rolling down it. It goes on gaining momentum and getting faster and faster on condition you do not stop it. If you check it artificially anywhere you lose all your momentum and have to start all over again.

"I knew nothing could balk me of victory once the Germans had accepted the final battle where they did. One thing only could have delayed defeat for them. That was to get all their forces from everywhere back behind the Meuse. That would have been a formidable position. If they had done that, well, we might have been there yet. But they could not do it. Why? Because it would have been an open confession of defeat, and they dared not face the moral effect of that at home."

The Marechal went on to talk about the armistice.

"When the Germans came to me to ask for an armistice, I said: 'I am going on to the Rhine. If you oppose me, so much the worse for you; but whether you sign an armistice or not, I do not stop until I reach the Rhine.' They preferred to sign and the result was that we arrived on the Rhine more quickly than we should otherwise have done. The main thing was to get there.

"What would have happened if the armistice had not been signed when it was?

"I should have attacked on Nov. 14 with twenty divisions in Lorraine. I should have taken Metz. The Germans would have evacuated it, in fact. But they had behind them the line of the Sarre, where we should have had to pause again. To have launched that attack would mean one victory the more, but that is all, and we got by the armistice everything we could have gained by the battle."

In reply to the question, "Would you not have captured large masses of the enemy if the Germans had not given in when they did?" the Marechal forever laid the ghost of the widespread report that the signing of the armistice deprived him of a great opportunity to force a German debacle.

The Marechal took up his pencil again and sketched a rough chart of the battle line. "When you are advancing on the whole of a 250-mile front, as we were," he said, "great encircling movements are impossible. As your adversary falls back he blows up bridges here and there. He blocks this road and this and this. He covers every track and line of pursuit with the litter of the material he abandons. The advance of the pursuing army becomes more and more difficult. You cannot get on fast enough to catch him. At the cost of great sacrifice of material he gets away. That is what modern war is like. It is not elegant, but it is like that."

The statement has been made that in the Meuse-Argonne offensive which occupied about 6 weeks, in the American sector on a 16-mile front about 30 miles in depth, casualties among the American troops resulted in 26,000 soldiers being buried in the American cemetery in the center of this sector. The country between the Meuse and the Rhine which I have driven over several times could have been as readily defended, I am sure, as the Meuse-Argonne had the Germans decided to resist the continued advance of the Allied troops, and the time necessary to have accomplished the objective of the Rhine is very problematical. Marechal Foch's decision was, to say the least, entirely satisfactory to every officer and man in the combat divisions at the front during the final weeks of the war.

There appears to be some vagueness as to the purpose of the Permanent International Armistice Commission. It will be recalled that the armistice conditions which Marechal Foch presented to the German delegation for acceptance were very general in their terms and necessarily required interpretation in connection with working out details, and the Armistice Commission, which was organized directly after the signing of the armistice and sent to Spa, the last great headquarters of the German Military Staff on foreign soil, was made up of delegations from the four Allied armies on the Western Front. Our delegation was headed by a general officer with a chief of staff and included a representative of each of the arms of the service concerned with any of the armistice conditions and terms. There was a representative of the railroad service, the artillery, the Signal Corps, the Air Service, the Engineer Corps, the Motor Transport Corps, etc. Each morning the Allied Armistice Commission met with the corresponding commission from the German side when the interpretations of the general conditions were made and instructions given to the Germans as to the procedure by which they were to comply with them. Although the German delegation endeavored to secure some relaxation of the severity of the terms, frequently making serious efforts to evade their admitted responsibilities, the Allied delegations were absolutely a unit in their firmness in requiring complete compliance. In some instances failure to comply resulted in penalties being imposed, and eventually the German delegation concluded that they might as well accept the inevitable and do their best to carry out their agreements. But this was not on account of any desire on their part to do any more than they were actually forced to do by fear of penalization. There was no question in the mind of the German delegation that their army had accepted a decisive military defeat, whatever the impression may have been which the German press, the army and civilian officials tried to make on the minds of the rank and file of the German army and the civil population.

Military Rule in the Occupied Zone

Having visited several points in Germany immediately upon the occupation of our sector in the Rhine provinces, I found a feeling on the part of the civil population that the cessation of hostilities was not due to a military defeat, and that a negotiated peace would ensue in which the Germans would have the same status as the Allies seemed to them quite probable, but before I left Germany in the latter part of March this idea had been completely dissipated.

Having completed the specific duties with which I was charged as a member of the Armistice Commission, I left Spa at the beginning of January together with some of the other officers who had also completed their portion of the work, and shortly thereafter went to Coblenz for the purpose of making investigations of the German military motor transport equipment and forming the collection of vehicles for engineering research, which is now at Camp Holabird, Baltimore, and six samples of which are being exhibited at this meeting. The American Army was the ruler of the occupied German territory in fact as well as in theory. The administration of the cities and towns was handled ordinarily through the local German

authorities under the orders of the American military commanders. Any infractions of rules or regulations in the conduct of the German people in this territory were punished at first by fines but latterly by imprisonment, and after the jail at Coblenz had been filled, and a second building pressed into service as a jail had also become fully tenanted, the infractions on the part of the civilian population were materially reduced.

Statements have been frequently heard that the Germans in the occupied territory treated our troops in some ways better than did the French in the portions of France which our troops occupied. I cannot understand why any comparison should be made between the treatment which we exacted from the Germans as a conquered enemy and the treatment which we received from the French whose guests we were and who did so much in the way of equipping our organizations and lending every possible assistance to the success of our armies. It will be very unfortunate if ill-considered and impulsive criticisms of the French are permitted in any way to affect the very harmonious and agreeable relations which existed. An army such as ours contains all sorts of people. Some of them presented sociological problems to us here at home before they became soldiers, and this sort of men would adversely criticise any conditions in which they might find themselves. The general dissatisfaction with service in the Army undoubtedly promoted others to criticize the country in which they were serving as one of the causes of this state of mind. I am sure that the most intelligent element in the A. E. F. regards the French as a most admirable, efficient and hospitable people.

In connection with criticisms a great deal has been heard about the alleged failures of the auxiliary organizations in the A. E. F., particularly the Young Men's Christian Association. Those of you who have interested yourselves in charitable or philanthropic organizations have had the experience that the criticism of your organization has always come from its beneficiaries, and I am anxious to testify from my observation and personal experience that the auxiliary organizations maintained a high average of effectiveness, working under the most severe difficulties and filling a field of usefulness which the Army had no form of organization to replace. In connection with recreational and educational facilities especially, as well as in the distribution of material comforts and luxuries, these organizations contributed very largely to the morale of the troops.

AIRCRAFT WIRELESS

WIRELESS telephony was a fact before we entered the war, and a thoroughly American development. Radio speech was transmitted between United States Navy vessels at sea in 1915, and across the Atlantic to the Eiffel Tower in Paris, and over the Pacific to the Hawaiian Islands in the same year. These installations required elaborate apparatus, of course, so that when Uncle Sam's Signal Corps asked the scientific staff of the Western Electric Co. to develop aircraft wireless, obviously it set a man's task, since all the equipment for generating radio currents and transmitting and receiving speech, and the antennæ for catching speech out of the air had to be reduced in size and weight, so that they could be carried on an airplane. More than that, they must not interfere with other apparatus or give the aviator any trouble.

Right there the fun began. The wireless engineers had to make their own power with a little wind propeller, after trying storage batteries. The airplane wing specialists viewed antennæ proposals apprehensively, and wireless engineers had to devise a trailing wire behind the propeller to pick up their radio talk. There was still a box or two to be stowed aboard somewhere, and they had to get space by haggling with other specialists. Aviators themselves did not view the wireless with any joy when it was first proposed; they thought battle flying already complicated enough; in fact, though born in wartime, and likely to grow into a useful adult, aircraft wireless was more or less a foundling in its first days.

Fully two years before the European War Capt., now Col., C. C. Culver demonstrated the practicability of working wireless telegraphy between an airplane and the ground. As aircraft developed on the Western Front his views about wireless maneuvering were supported by war experience; and in February, 1917, he achieved wireless communication between an airplane and a ground station at San Diego, Cal. An invention like aircraft telephone could not be the product of one man. It was an achievement of massed invention. The desired end was discussed, defined, split into units, and parceled out among specialists in widely different fields. It was invented in a thirteen-story skyscraper down on New York's North River front, a workshop wholly given up to telephone research. To get good results from one man a dozen were set at a single detail, and to get the happy device that finally did some part of the business often a dozen or more were developed and cast aside.

An American Invention

Nothing whatever had been done abroad in wireless telephony. Aircraft fighting had reached a point where instantaneous communication by telephone promised military advantage equivalent to radical increases in speed and flexibility. The tools of war are pretty well standardized. All combatants have the basic things, rifles, high explosives, aircraft, submarines. Military advantage depends chiefly on perfecting something a little better along standard lines and making it count before the enemy can adopt it, which will not be long. Aircraft had been boosted up to top speeds and mobility, and also fought in fleets under battle formation. The very essence of fleet maneuvers was communication; and beside the instantaneous telephone all signaling systems were cumbersome. Basic principles of wireless telephony had already been worked out so thoroughly that the chief remaining problem was to devise special aircraft apparatus.

Actual conversation between planes in the air and the ground was simple enough if other difficulties could be overcome. Apparatus had to be as light as possible. A suitable powerplant was needed. Perhaps the greatest difficulty of all was to make telephone conversation audible to men flying in the air, where noise from the engines and propeller made ordinary conversation impossible. There were also electrical disturbances arising from the ignition system, which affected the wireless telephone.

In July, 1917, five weeks after the first conference, an experimental set was demonstrated at Langley Field, Va., conversing between an airplane and the ground. Five months later, at Wright Field, Dayton, Ohio, there was a demonstration of telephoning between the ground and two planes in the air, and also between the planes aloft. Each plane had a pilot and an observer, both receiving messages, and the observer was able to talk with the ground or the other planes. The first maneuvering of planes in the air by telephone was then effected.

Up to that time communication between an airplane and the ground on the Western Front had been wholly by wireless telegraphy. For the most part, an aviator telegraphed ranges and results of artillery fire from plane to ground. He had to be trained in the Morse code. Only occasionally was telegraphing possible from ground to plane, and communication between planes in the air was limited to crude signals.

Making Conversation Audible

One of the knottiest problems was that of making telephone conversation audible to the aviator in the air. This called for a soundproof helmet. Many experiments were made with sound-deadening materials and with forms of earpieces. The form of earpiece finally adopted was made of porous sponge rubber, reenforced with tin foil, and telephone receivers imbedded therein. These were fixed in a thick leather helmet, to be clamped over the aviator's head and ears.

The problem was not solved by earpieces only, for man does not hear through his ears alone. After your ears have been successfully muffled, the bones of your skull, and especially the cheek bones, will transmit enough noise to interfere with good aircraft telephony. Therefore, the helmet had to be so designed that this bone transmission was muffled. Just when the telephone experts got their soundproof helmet right, the oxygen-mask specialists announced that nothing must interfere with giving the aviator oxygen at high altitudes, so the sound-proof helmet had to be modified to meet one more condition.

How completely the desired end has been attained is shown in an amusing circumstance connected with aircraft telephony, for the aviator can hear others speak from a distance of from 6 to 10 miles, and catch low-pitched conversation with a clearness and richness of harmonics not possible by an ordinary wire telephone; but the helmet so effectually muffles his own hearing that he cannot hear himself reply. He speaks, and is heard, but is not certain of it. Indeed, this has been found something of a handicap, for the aviator is led to raise his voice and shout, and, until he becomes accustomed to the novelty of talking and being heard by everybody but himself, he will worry for fear his talk is not getting through.

There were other puzzles, connected with the transmitter. This had likewise to be muffled from airplane noises, but along entirely different lines. Obviously the aviator's mouth could not be padded with sponge rubber and tin foil. The transmitter was made quite simple in form, and also quite bare. Instead of the wide mouthpiece through which one talks in an ordinary telephone, it has three tiny openings, not larger than the diameter of pencil lead. When the aviator talks into these openings the sound waves strike directly and exert pressure not unlike three tiny rods pushed against the microphone. But airplane sound waves, however strong, swirl round it in other directions and do not enter in sufficient volume to be heard at all.

Airplane talk is now picked up either by a stringlike copper wire trailing 50 ft. out behind the machine in flight and wound up before landing, or through a copper wire stretched like a fiddle string along the length of the top wing. On the ground a portable umbrella type of antennæ is used, a 15 or 20 ft. pole, with wire guys from its top to the ground.

By suitable adjustment for distance, wireless talk between battleplanes can be limited to almost any radius desired, from a few hundred feet to 100 miles. This makes secrecy possible, assuming that enemy planes are also equipped with wireless; because orders may be given and battle plans perfected before the enemy, though in sight, comes within listening distance. By simply moving a switch in front of him the aviator can lengthen or shorten the talk range.

Quantity Production

When development of aircraft wireless was begun, not more than fifteen or twenty commercial wireless-telephone sets had ever been made. The vacuum tubes were fabricated by hand. One hundred weekly was a large output. By the time Germany signed the armistice they were being made at the rate of 25,000 weekly.

The vacuum required is the highest thus far known, and would not have been attainable at all 5 yr. ago. It can be expressed as one billionth of an atmosphere. The plates and grids are made of nickel and the filaments of platinum with a coating of rare metallic elements. Merely to use platinum for the four posts through which electricity enters and leaves the tube would have required prohibitive quantities of this fearfully scarce metal, so a substitute had to be found.

Clearer transmission will eventually be gained in all telephony through this achievement; while the wireless itself promises to be exceedingly useful in certain fields. Aircraft wireless pulled down the cost of apparatus, lowered its weight and made it more simple, so experts already see some practical use for it.

A wireless-telephone outfit of aircraft type costs more and weighs more than a radio-telegraph outfit, but it can be used by people who do not know the Morse code.

At present an outfit for two-way conversation over a radius of 20 miles weighs 100 lb. and costs $500. Two years ago it weighed 500 lb. and cost $2,000.

Assuming that you wish to talk by wireless in a radius of 20 miles, whether it be on an exploring expedition in Africa or over impassable mountain country in our Western mining regions, you can now have an outfit perfectly practical and portable. There will be two sets for two-way conversation, each a box affair weighing 50 lb. One end ought to be connected to ordinary electric service, such as is available in towns. The other set can be operated by a small storage battery or a nest of 150 small flashlight dry batteries, weighing about 15 lb., giving 2 hr. of continuous conversation. The antennæ will be a fishing pole, set up anywhere you please and held by a few wires.—J. H. Collins in *The Saturday Evening Post.*

AIR MAIL SERVICE RECORDS

A RECORD of 99 per cent was made by the Air Mail Service between Washington and New York for the month of June, covering a mileage of 11,118 and carrying 15,643 lb. of mail. On the Cleveland-Chicago division a perfect score of 100 per cent was obtained. A total of 19,825 miles was flown in the month of June on that division, and a total of 19,603 lb. of mail was carried. The average speed on that route for the month was 97.8 miles per hr. The best flying was performed on June 18, when the round trip from Cleveland to Chicago and return was made in 6 hr. and 14 min., an average of 104.4 miles per hr. in each direction. The operation of the Cleveland-Chicago route is without parallel in the history of aviation. The route was started May 15 and has never missed a day, seventy consecutive daily non-stop flights of 325 miles each were made without a forced landing. On the seventy-first trip a gas line connection sprung a leak, causing a forced landing on the emergency air mail landing field at Bryan, Ohio. The route from New York to Cleveland, across the Allegheny Mountains, has been operating with the same degree of perfection as the Cleveland-Chicago route since July 1. A new air mail route is planned in connection with transatlantic steamers sailing from New York.

Lighter-Than-Air Craft[1]

By Lieut.-Col. T. R. Cave-Browne-Cave (*Non-Member*)

Illustrated with Drawings

SINCE I was asked in September last to read this lecture conditions have so changed that it has been necessary totally to recast and rewrite what I then proposed to say. A large amount of information as to the actual achievements of airships has been published and also perhaps an even larger amount of speculation as to their future possibilities. What will, therefore, probably be of interest to a technical society such as this is a general outline of the ships as they exist at the stage to which they have been developed during the war.

To make clear the various matters which influence the lift and behavior of an airship, I have introduced a small amount of aerostatics which will appear obvious and unnecessary to many, but may help others to the understanding of the more interesting points treated later.

The extent of the detail which I have been allowed to include in the lecture, although such matters have not been published before, leaves the Society with a very deep debt of gratitude to the Admiralty.

Factors Governing the Variations of Lift

An airship derives her lift from the difference between the weight of the structure and all parts of the airship and the upward force on the airship, which is equal to the air which she displaces. The majority of this displacement is that due to the part of the ship which is filled with gas. The variation in lift of the ship will therefore depend primarily upon the volume of gas in her envelope and upon the density of the surrounding air.

As the ship increases her height from the ground the density of the surrounding air decreases, and owing to the decrease of pressure the hydrogen contained in the gas space will expand at a corresponding rate so that, other things being equal, the available lift of the ship will remain the same. This process will continue until a height is reached at which the air has been totally expelled from the air chambers and further expansion of the gas necessarily results in the discharge of some gas from the relief valves in the envelope. Any further rise will, therefore, produce a decrease in the lifting power of the ship.

Alteration of atmospheric temperature is usually accompanied by a corresponding alteration of temperature of the gas, and providing the two temperatures remain the same, there will be no effect on the lift, so long as gas is not discharged from the envelope.

Variations in barometric pressure or density of the atmosphere affect both the density of the air and the density of the hydrogen, and a ship which is full of gas will therefore have considerably greater lift on a day when the barometer is high. This indicates that the lift of a ship may be expected to be good during cold weather with a high barometer. Summarizing this in symbols:

Lift $= V\ (Pa - Pn)$ where
V = volume of gas space
Pn = density of gas
Pa = density of air displaced

[1]A paper read before the Royal Aeronautical Society of Great Britain.

An important variation in lift is caused when the airship is exposed to the heat of the sun and the temperature of the gas inside the envelope becomes higher than the temperature of the surrounding air. The extent of this difference of temperature will vary with the strength of the sun and also with the rate at which the surface of the envelope is being cooled by the passage of air over it. This difference under certain circumstances may be very large and may vary rapidly. Instances have been recorded in which there has been a difference of over 30 deg. fahr. between the gas and air temperatures. The gas temperature reckoned on the absolute scale was then some 6 per cent higher than that of the atmosphere and a "false lift" of 6 per cent of the total displacement of the ship was therefore produced.

The reduction of lift caused by rain falling on an airship is comparatively small provided the surface of the envelope is made waterproof. Snow will not in general stick to the surface of an envelope, but in the event of meeting snow sufficiently wet to stick to the surface, and possibly later to freeze on to it, a marked increase of weight might very rapidly be acquired. There has been considerable experience of ships meeting snow while in flight, and as far as is known no serious trouble has actually been experienced due to snow sticking to the surface of the envelope.

Distribution of Weight and Rigidity of Envelope

The problem of suspending a weight from the lightest possible gas container is one which involves careful consideration of the ordinary principles used in calculating the distribution of loads and bending moment in ships and similar structures. The rigidity of the gas container may be provided in various ways. The simplest is to make it solely of a perfectly flexible fabric with no rigid stiffening whatever. Such an envelope is referred to as a non-rigid. It is kept distended to its correct shape by the internal pressure, which is maintained slightly in excess of the pressure outside. Fabric may be regarded as capable of resisting tension and a considerable amount of shear, but it is, of course, incapable of resisting compression. A single concentrated load suspended below the envelope will tend to produce compression in the underside of the envelope, partly by reason of the inward pull of the riggings, some of which must necessarily be inclined from the vertical, and also by any bending moment due to a lack of uniformity of distribution of load over the length of the envelope. The internal gas pressure produces a longitudinal tension in the fabric. If the compression due to the riggings exceeds the tension due to the internal pressure the envelope will deform.

An alternative method of maintaining the shape of the gas container is to form the hull of the ship as a rigid structure of sufficient stiffness to maintain its own shape independent of any internal gas pressure. The forces tending to deform this structure will depend upon the distribution of loads and upon the distribution of gas inside the hull. Ships constructed on this system are described as rigids.

Intermediate between these two main types there is one referred to as the semi-rigid. This class is provided with a rigid keel of sufficient strength to maintain its rigidity under the action of the various loads of the ship. The keel is carried by the envelope which contains the gas, but unlike the rigid the envelope is dependent for its shape upon the excess of internal pressure. There is yet another type, one that is extensively used in Italian airship construction, in which the keel is not capable of taking a bending moment but is capable of taking longitudinal compression when held straight by the main envelope.

Of these various types of construction it may generally be said that for small ships the non-rigid arrangement is entirely satisfactory as the envelope is amply capable of providing sufficient rigidity with reasonably small internal pressure. For very large ships it becomes necessary to divide the gas chamber into a number of compartments for a reason which will be explained later, and also the large diameter would render the tension in fabric caused by the necessary excess of internal pressure very considerable. For this reason a rigid structure, which calls for no excess of internal pressure, will almost certainly have to be adopted for airships of the largest class. The semi-rigid is a type which has been practically undeveloped in this country. The Italians, however, have done a great deal of work on ships of this description, but it appears very doubtful whether, all other things being equal, there is much to be gained by the addition of a rigid keel to a non-rigid envelope. The keel of a semi-rigid ship has to be sufficiently strong to take the loads of the airship without the assistance of the envelope, because in the event of pressure in the envelope falling the keel would collapse, and the ship could not be restored to her correct shape by making good the pressure in the envelope. Non-rigids which have lost pressure have frequently buckled in the air to a seemingly alarming extent, but have continued their flight undamaged as soon as pressure has been restored. The Italian system of providing a keel capable of taking only longitudinal thrust is an extremely ingenious one, but it is not found in actual practice that very much advantage in overall height of the ship can be effected by this method. This, of course, is due to the fact that the points of attachment of the riggings are moved down from the level of the center of the envelope to the level of the keel.

The design of the envelope of non-rigid ships is a matter which requires a very considerable amount of careful consideration. The overall height is restricted by the size of the airship shed and also by the power of the elevators which are required to incline an airship the car of which is far below the center of the envelope. If the weight is concentrated and placed close to the envelope the riggings necessarily lie at a very flat angle and exert a serious longitudinal compression. This has to be resisted by a high internal pressure, which in turn causes great circumferential tension and involves the use of correspondingly heavier fabric for the envelope.

The general consideration of the rigidity of an envelope is one of very considerable complexity and may be most conveniently tackled by arranging a model experiment in which the lift of the gas and the distribution of load is reproduced in a small envelope filled with water and inverted, the weight of the water acting downward corresponding with the lift of the gas acting upward in the full-size ship. The load is taken by a number of wires arranged similarly to the riggings and passing over pulleys which support the equivalent of the load of the airship. The weight of the planes and other envelope fittings can similarly be represented. Pressure in the envelope is maintained through a tube connected to a water reservoir, the level of which can be varied. A convenient method of determining the pressure in the water model, which shall correspond to similar pressure in the airship, can be obtained as follows: The pressure in an airship could be maintained at any desired value by fitting a hose to the bottom of the airship and filling the envelope with gas until gas issued from the lower end of the hose. If the end of the hose is at a distance of M meters below the bottom of the envelope the pressure of gas at the bottom of the envelope will, as explained later, be M millimeters of water above atmosphere. Similarly in the water model, the height of the free surface of water above the envelope corresponds to the internal pressure at that point, and as the dimensions of the model and the envelope have been arranged correctly to scale, the comparison is a direct one. For example, if the diameter of the airship is 15 m. and it is desired to maintain a pressure of 20 mm. of water at the bottom of the envelope, the length of the open hose must be equal to 20 m., that is, 20/15 of the diameter of the envelope. This is reproduced in the water model by maintaining the water surface at a distance above the envelope equal to 20/15 of one diameter.

Experimental Methods

The method of carrying out these experiments is a very simple one. The various loads are distributed along the envelope and the pressure is reduced until the fabric begins to pucker at some point. The value of this pressure is noted. The distribution of load may then be varied to reduce the compression in the fabric at this point.

It is desirable to arrange the water model so that the whole system can be inclined up or down at one end to reproduce the conditions of the airship pitching. Provision against pitching occasions greater difficulty than the mere satisfactory suspension of the load when the ship is on an even keel. It is not possible to give any simple rules for arranging the rigging of the non-rigid ship, but one system which has been found generally satisfactory is to lead wires from points distributed along the envelope at intervals suitably proportioned to the lift of gas at each section. This provides for the suspension of the load on an even keel. Independent wires should then be provided to prevent "fore-and-aft" motion of the airship car when the ship becomes inclined. It will easily be seen that the tendency to deform the envelope very materially reduces as the distance of the load from the envelope is increased and also if the load can be divided into one or more separate units.

The point at which the riggings are attached to a circular envelope is necessarily some distance below the axis. If it is possible to raise the level of these points of suspension to a higher point on the envelope, the height of the ship can be correspondingly reduced.

Further, the direct longitudinal compression due to the riggings is applied at a point considerably above the axis of the ship, *i.e.*, at a point where the difference of pressure and therefore the longitudinal tension of the ship is greater than at the lower levels. This principle was satisfactorily achieved in the system invented by a Spaniard, Signor Torres Quevedo, and subsequently developed by the Astra Co. of Paris.

The envelope is made of trilobe cross-section and the

riggings are led into the envelope at the bottom ridge and parted into two fans of strings secured to points along the top ridges.

To constrain the envelope to this trilobe shape, curtains of ordinary unproofed fabric are laced to the ridges. These do not, however, divide the ship into separate gas compartments.

The system adopted by the Parseval Co. is to provide a strong rigging band as a kind of girdle on the lower part of the envelope. To this the car is attached. The shape of the envelope is maintained by reinforcing bands of webbing stuck to the surface of the envelope along trajectories, the position of which is determined by experiment.

Both these systems and also the semi-rigid design involve considerable complexities and are only rendered necessary to suspend a concentrated weight as close as possible to the envelope. If, however, it is not necessary that the weight should be concentrated and it is possible to distribute the majority of the weight in a number of separate cars or along the envelope itself, these systems and the complexities they involve can be abandoned.

Structure of Rigid Airships

The framework of a rigid airship consists of a number of rigid longitudinals connected by a number of transverse members, which form rings at intervals along the length of the ship. Each of these rings is braced in its own plane by a number of radial wires. The gas bags are placed in the compartments between these bulkheads of radial wires. The outer cover is stretched over the outside of the framework.

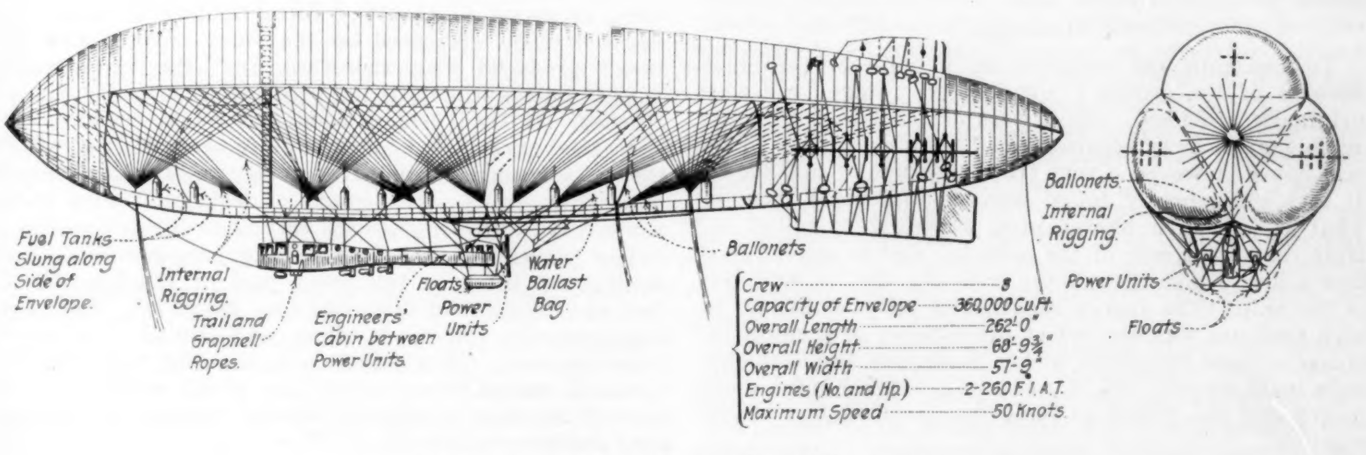
To transmit the upward pressure of the gas bags to the framework, nets are provided and attached to the inner edges of the various rigid members of the framework.

The weights carried by the ship are mostly placed in a strong keel, which runs along the bottom of the ship. The function of the keel is primarily to distribute the load of these weights to the main transverse sections of the ship. The cars which are suspended below the hull of the ship are also attached at points which bring the load on the main transverse bulkheads. Special lift wires are arranged, in addition to the radial wires, to transmit the load of the keel to the upper part of the framework.

If, for any reason, one gas bag becomes much less inflated than those on either side of it, there will be considerable pressure tending to bulge the radial wires toward the empty bag. Tension in these wires may produce very serious compressive strain in the transverse members, and to aid in resisting the bulging action an axial wire is often led along the axis of the ship and secured to the wires of each bulkhead.

Subdivision of Gas Space in Large Airships

The necessity for dividing the gas space into a number of separate compartments is not primarily due to the possibility of losing the whole of the gas from one compartment by leakage from external damage to the fabric. As long as an airship remains on an even keel the pressure at the two ends of the ship will be approximately the same, but if the airship be now placed vertically head upward the excess of the internal pressure at the top of the ship over that in the air outside will be considerably greater than that excess at the bottom of the ship. This is due to the difference in weight of a column of air and a column of hydrogen equal to the length of the ship. The same variation of internal pressure will obtain in a lesser degree when an airship in ordinary flight has one end raised considerably above the other. It is convenient to remember that this variation of the difference of pressure amounts to 1 mm. for each meter difference in level. In the case of a non-rigid, which has to maintain a minimum difference of pressure between the inside and outside of the fabric of 15 mm., the effect of having the bow of the ship raised considerably above the stern will produce a large increase of pressure difference in the bow and consequently an increase in tension of the fabric at that point. In a short trip this increase of pressure due to inclination of the ship is small, but in ships of great length the increase would be a serious one. For this reason it becomes necessary to divide a long ship into a number of compartments, but this is only effective if the bulkheads, which isolate one compartment from another, are capable of maintaining difference of pressure between their two sides. In a rigid airship which has a number of separate gas containers arranged inside its structure this division is effective. There is, therefore, no accumulation of pressure at the higher end of the ship. The radial wires which form the bulkheads between the



Arrangement of the British Type N S Airship

gas bags are capable of withstanding a certain difference of pressure between the gas on the two sides of the bulkhead.

Subdivision of the gas space is also desirable to avoid the surging of gas from one end of the ship to the other. An airship partly filled with gas would, if not subdivided, tend to be very unstable, as the gas would tend to run to whichever end happened to be the higher. In a non-rigid ship this surging is satisfactorily avoided by subdividing the air space into a number of ballonets so that the air in each can only move a short distance forward or aft.

As indicating the method by which a steel wire may be attached to fabric and communicate the load to the envelope, the diagram shows such a fitting used for the main rigging for small non-rigid airships. The wire is passed through a tubular D-piece, round the outside of which are laid strips of webbing. These are stuck to fabric foundations which are extended over a small portion of the envelope. This construction serves satisfactorily to communicate the tension in the wire to the envelope and to give reasonably good distribution of stress.

Blowers

To maintain the pressure in a non-rigid envelope, blowers of the ordinary low-pressure rotary type were originally provided. These were driven either from the main engines or by separate small gasoline engines. They occasioned, however, a very fruitful source of breakdown. It was subsequently found possible to replace them by what is termed a blower pipe, arranged to collect air from the slip-stream of the propeller and to discharge it into a duct which distributes it to the various ballonets of the ship. The energy required to provide this air at high pressure was derived at the expense of a slight increase in head resistance, and to avoid this arrangements were made whereby the blower pipe could be hinged about its top end and folded up along the under surface of the envelope.

A method which is employed in Italian airships is to derive the pressure from the extreme bow of the envelope. The sufficiency of this pressure will be discussed later.

The distribution of this air to the various ballonets necessitates the use of shut-off and non-return valves. These were originally made from sheet aluminum and gave very considerable trouble. It was found, however, that fabric valves arranged in the form of a sleeve, which can be partially turned inside out, gave very effective results. This valve is referred to as a "crab-pot." It is very easily operated and is almost completely airtight. The diagram shows the arrangement of blower pipe and valves on the smallest type of ship.

To enable pressure to be maintained when the main engines are not in use an auxiliary blower is necessary. The rotary type of blower driven by a separate small engine was used for a considerable time but proved capable of improvement both as regards space occupied, reliability and efficiency. A new type of blower was devised and consisted of a small specially designed propeller discharging into a casing, shaped so as to avoid as far as possible all loss due to eddies. The shape of this orifice was very carefully determined and a large boss fairing was fitted to the propeller.

Careful tests made by measuring the horsepower and output of air showed that for the same horsepower and discharging against the same head the new blower would deliver three times the amount of air previously discharged by the rotary blower.

Airship Valves

To prevent the pressure in the envelope exceeding a predetermined maximum and causing danger of bursting, valves are provided to relieve the pressure in the ballonets and in the gas space. The valves are made automatic in their action, and the gas valve is set to blow off at a pressure somewhat in excess of that adopted for the air valve, thereby insuring that an increase of pressure is first corrected by discharging air from the ballonet valves. If this rate of discharge is insufficient the gas valve then lifts, but the discharge of gas is avoided wherever possible.

It will be realized that if these valves were constructed and spring-loaded in the ordinary way, the pressure of the valve on its seat would be gradually reduced as the pressure inside the envelope increased. When the blowing-off point was nearly reached there would be a considerable period while the valve was only very lightly pressed on its seat and when leakage was extremely likely to take place. The mechanism of the valve was, therefore, arranged so that the force tending to cause the valve to open decreased as the valve opened, and the result produced was, therefore, that the valve would remain on its seat until the predetermined pressure was reached. It then opened wide and would remain open until the pressure had fallen slightly below that at which the valve opened. This gives a very positive action and materially reduces the amount of leakage from a valve while it is "stuttering" in the very slightly open position.

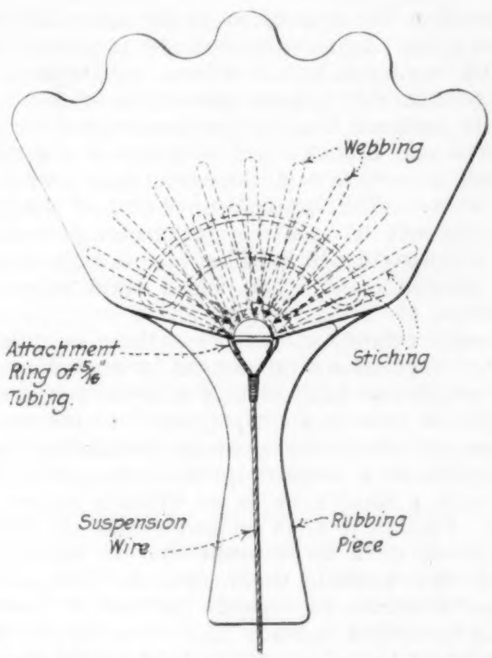
The gas valves used for relieving pressure in a rigid airship are fitted in the lower part of the bag where they can be reached from the keel gangway. They are automatic but are much larger and loaded to a much lower pressure. In addition to these relief valves, hand-operated maneuvering valves are fitted at the top of most of the bags so that gas can be released in order to alter the trim of the ship.

Bow Stiffening for High Speed

The pressure which it is necessary to maintain in a non-rigid envelope depends upon two things: First, the pressure which is necessary to prevent the envelope from collapsing under the influence of the rigging tension; and second, the pressure which is necessary to prevent the bow of the envelope being blown in, due to the excess of external pressure caused round the bow of the envelope by the motion of the airship forward.

It is found that the excess of pressure which takes place at the bow of the ship extends for only a short distance aft. By reinforcing this area it is possible to fly with an envelope pressure considerably lower than the external pressure at the bow of the ship.

This stiffening of the bow becomes a matter of greater importance as the speeds increase. There is always the possibility in "bumpy" weather, when the height of the ship varies rapidly, that the pilot may let his pressure fall momentarily too low. The bow of the envelope then blows in and forms a curious concave cup shape in which it remains till the speed is reduced or the pressure is raised. No damage will probably be done so long as the reinforcement of the bow is not of such a nature that it will break and puncture the envelope. It may very probably be necessary to provide a separate small compartment at the bow which is kept at a higher pressure than that of the rest of the envelope. This would allow



Fitting Used on the Main Rigging of Small Non-Rigid British Airships to Transmit the Weight of the Car to the Envelope

high speeds to be attained without a corresponding increase in envelope tension.

Fabrics

The fabrics used in airships are of three main types:

(1) Gastight fabric, such as that used for gas bags of a rigid ship

(2) Outer cover fabric, of which the principal function is to form a rain and weatherproof outer cover to the ship, both as a fairing to reduce her resistance and to protect her internal bags from variations of temperature, due to radiant heat, and from deterioration caused by sunlight

(3) The envelope of a non-rigid ship requires a combination of both properties

Gastight Fabric

The lightest method of rendering a fabric gastight is the application of goldbeater's skin. This material is a membrane which, although water will easily pass through it, has a very pronounced ability to resist the passage of hydrogen. The skins are obtained from the messentry of a cow, each animal contributing a piece which averages about 8 by 20 in. These skins are stuck to the fabric by glue or rubber solution and are varnished to protect them against moisture and damage.

The gastightness of a non-rigid envelope is obtained by rubber proofing only. The same fabric has to fill the functions of an outer cover, as stated above, and also has to withstand considerable stress produced by the internal pressure of the gas and by the tension of the riggings attached to it.

To obtain the necessary strength, and more particularly strength to resist tearing, a number of plys of cotton fabric are stuck together with layers of rubber solution between them. Fabric for a small size ship can be given the required strength by two plys of cotton, the inner one being diagonal. Stronger fabric is usually made of three plys, the middle one being diagonal. The diagonal ply is formed by cutting strips of fabric and sticking them to the other ply so that their threads run at 45 deg. to the threads of the main ply and to the length of the built-up strip of fabric. These diagonal threads have a very pronounced effect in distributing a stress evenly over threads of the main ply.

The rubber is made into a thick solution and spread by a kind of scraping knife on the layers of fabric before they are stuck together.

The rubber on the outer surface usually contains aluminum powder, as this forms a surface that reflects much of the radiant heat, thus preventing rapid temperature change, and is also opaque to the light, which would injure the fabric inside. It is usually found that the outer layer of proofing has perished so badly as to be easily noticeable before the strength of the fabric has become appreciably reduced by weathering.

Outer Cover Fabric

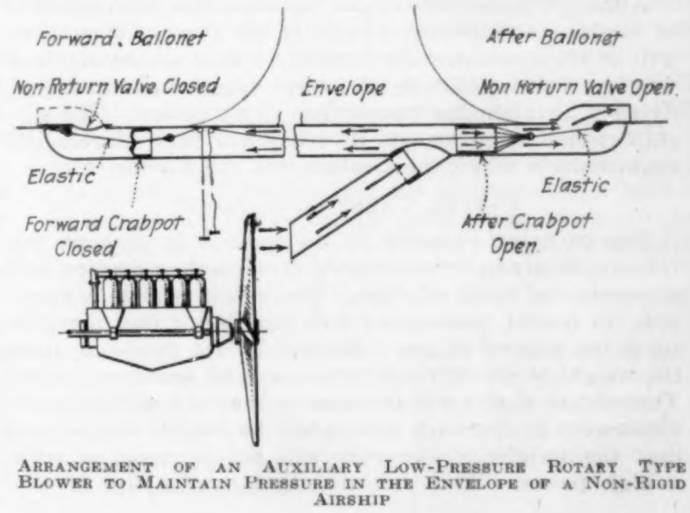
Outer cover fabrics generally resemble the fabric used on airplane wings. It is necessary after the outer cover is placed on the ship that a certain degree of contraction should take place so that the cover may be well tensioned to resist any tendency to flap. It is found that a contracting cellulose acetate dope is generally most satisfactory, but the extent of the contraction must be considerably less than that customary on airplanes. If the contraction is excessive it is liable to bring a serious crushing strain on the framework of the ship.

Considerable difficulty has been experienced in obtaining a satisfactory dope for the outer cover, but its functions in resisting light and heat and in providing a waterproof covering are so closely analogous to those fulfilled by the latest airplane dopes that it is probable airplane practice will be adopted, the only modification being a considerable reduction in the amount of contraction allowed.

The outer cover of a rigid airship constitutes a very serious problem because the unsupported areas of the fabric are large, and it is of the utmost importance that no part of the fabric should flap or even tremble to a slight extent. Such action would increase very rapidly, and in the prolonged flights which these ships have to make very serious results might follow any slight flapping which was allowed.

Planes

To stabilize the motion of the ship it is necessary to provide the envelope at the after end with planes. These are provided at their after edges with rudders capable of steering the ship either vertically or horizontally. The construction of these planes somewhat resembles that



Arrangement of an Auxiliary Low-Pressure Rotary Type Blower to Maintain Pressure in the Envelope of a Non-Rigid Airship

of the wing of an airplane. Fabric is stretched over a framework and doped to render it taut. The surfaces are, however, practically flat and the loading is considerably less than that provided for in an airplane.

The planes are supported from the surface of the envelope by guy wires attached to suitable points on the envelope and are prevented from pushing their inner edges into the envelope by skids or wooden bearers. The importance of the rigidity of this resistance to inward thrust is very often underestimated. A small inward movement of the foot of the plane allows the plane as a whole to sit over a serious angle. This lack of rigidity in the planes has a serious influence on the stability of the ship.

The maximum intensity of air pressure occurs toward the forward edge of the planes and it is, therefore, desirable that the leading edge should be short. The long, narrow plane, increasing in width as it goes aft, is, therefore, adopted in preference to that of large aspect ratio, which, although aerodynamically more effective, would be much more difficult to hold with adequate rigidity.

The planes of a rigid ship are attached rigidly to the hull framework. In the latest German ship these planes are made some 6 ft. thick at the root and faired off into the rudder and tapered to the outer edge. They are, therefore, almost totally self-supporting, and require no guy wires.

Engine Requirements

Our very extensive experience of airship flying, extending over nearly 3,000,000 miles during the war, has shown that by far the most fruitful cause of failure is connected with the engines. This is the case although a large proportion of the small difficulties which occur in aeronautic engines are of a type which can be made good in an airship, but not in an airplane. The length of time for which an airship's engine is running continuously is very much greater than that of an airplane. The requirements to be expected from a good airship engine, therefore, differ from those of an airplane engine in several important respects:

(1) The engine must be suitable for running for very long periods without breakdown

(2) All gear on the engine must be arranged so that small defects can be made good in the air; the engine, if necessary, being stopped for a short period

(3) The fuel and oil economy, more particularly at reduced powers, are of far greater importance to an airship than is the initial weight of the machinery

Although these differences between the requirements of airships and airplanes exist at the present time, they will be very considerably reduced as soon as the airplane develops into a machine of longer range and capable of flying with a smaller proportion of its power. The airship engine requirements of today are very largely the requirements which the airplane will call for tomorrow.

Useful Carrying Capacity

The carrying capacity of an airship is perhaps the feature of greatest importance from both a service and a commercial point of view. The weight which is available for bombs, passengers, mehchandise or fuel, depends upon the volume of gas contained in the ship and upon the weight of the ship's structure and all necessary parts. The volume of gas will increase as the cube of the linear dimensions of the ship, and it will be readily understood that the weight of the ship will not increase as such a high power. This indicates that as the size of the ship increases the proportion of her gross lift which is available for lifting capacity will also increase. The non-rigid ship, having no hull structure, will for the same size have a considerably greater proportion of available lift. It may be assumed that it is at the present time practicable to design both a rigid ship and a non-rigid ship which will be able to carry as useful load a weight equal to that of the ship; that is, 50 per cent of the gross lift of the ship will be available for useful purposes. The size of a non-rigid which will give this ratio is approximately 500,000 cu. ft., and for a rigid approximately 2,000,000 cu. ft.

For many commercial purposes there is much to be gained by carrying a given weight in several small ships rather than in one large one. For naval purposes, when the airship is used as a cruiser, her function is to carry observers and a wireless telegraph installation for a certain distance at a certain speed, and a ship that will do this with a small crew is as effective as one with a big one. To this it must be added that the small ship can get away on a large proportion of the days when the larger ship would be weatherbound. The best figures which are available as regards the cost of our largest rigid and non-rigid indicate that some six of the non-rigids referred to above could be built for the same price as the equivalent rigid referred to.

Water Recovery and Use of Hydrogen as Fuel

An airship which is making a long passage extending over several days has to contend with difficulties due to changes of temperature.

The change of temperature, and more particularly the change in the amount of radiant heat by day and night, is often very great. Let us trace the history of a ship which leaves the ground in the early morning, before sunrise.

As the day advances she warms up, and her lift will probably increase, due to superheat and the gasoline she has used. Unless she is prepared to keep herself down by using her elevators and flying nose down, she must rise and lose gas. Later in the day, when the superheat disappears, the ship may become seriously heavy due to the amount of gas she has lost. It is important, therefore, to reduce the gas lost, and this can best be done by avoiding the necessity of allowing the ship to go to a considerable height. For this it is necessary to take weight into the ship. This can be done by picking up water from the sea or by condensing the steam formed in the engine exhaust. The first method is possible only over the sea and by coming down to a low height. It even then presents considerable difficulty. There is, however, the advantage that a large weight of water can be picked up quickly when required. The weight of water that can be condensed from the exhaust is theoretically more than 20 per cent in excess of the corresponding weight of fuel consumed, but it is found in practice that to collect more than about 80 per cent of the gasoline weight would necessitate very heavy condensers.

It is almost certain, however, that at many times during a long journey it will be necessary to discharge gas, and arrangements have therefore been made to use the gas as fuel. Experiments were first made in burning hydrogen alone as fuel in the engine, but it was found possible to develop only about one-third of the maximum horsepower of the engine. If a greater quantity of hydrogen than this was burnt serious detonation took place in the cylinder. Trials were, however, carried out by using both hydrogen and gasoline, each mixed

with the correct proportion of air. By varying the proportion of the hydrogen and gasoline mixture it is possible to obtain all powers up to the maximum of the engine. At the higher powers only a smaller proportion of hydrogen can be burnt without trouble. No serious difficulties were experienced with the use of hydrogen as fuel, but it has been considered desirable that the gas should be drawn from the envelope at a pressure less than atmospheric to avoid any possible risk of fire. A spring-loaded non-return valve is fitted in the hydrogen discharge pipe and is loaded to a pressure considerably in excess of that which will ever be attained in the envelope. The suction of the engine is sufficient to draw the hydrogen through this valve, but if for any reason the engine stops, no further hydrogen passes. The apparatus has been most thoroughly tested to eliminate risk due to fire and it appears quite certain that at the present time the risks from a hydrogen fire with this gear are negligible.

Types of Airships Developed During the War

In 1915 the interest in airships was revived by Lord Fisher's decision that they might be made to form an important defence against the submarine. The first "S S" ship was constructed by suspending a "B E" airplane, stripped of its wings and tail, under a suitable small envelope. The trials of the first ship were made in less than 20 days from the time the instructions to proceed were received. The first flights were so satisfactory that the Admiralty gave instructions that the production of these ships was to proceed at once. There were at that time practically no firms capable of constructing airship envelopes or even of constructing airship fabric in anything like adequate quantities. The building up of this fabric and envelope constructing organization almost entirely among firms of waterproof garment manufacturers was not the least difficult or interesting part of our early airship development. It must be remembered that the firms which undertook this work were mostly totally unaccustomed to reading blue prints as the whole of their cutting had been done from patterns made elsewhere. The "S S" class of airship differed very slightly from the original ship in certain respects which had been found desirable on the first trial. A few cars of the "pusher" type which generally resembled the nacelle of a Maurice Farman, were constructed by a private firm, but although they relieved the pilot of the propeller slip-stream, they did not prove as satisfactory as the older "B E" type.

It soon became necessary to construct a ship of larger size and capable of lifting a greater load and of longer endurance. An envelope of the "Astra" type was obtained from a ship which had been built before the war as a Belgian millionaire's air yacht. A suitable car to take four men was constructed and rigged below it. This again proved a satisfactory preliminary experiment and was the beginning of the "Coastal" type. The envelope had to be redesigned, but the modifications made in the car were comparatively small. This class of ship was modified in 1918 to the type known as "C," which had again a better shaped envelope and slightly better crew accommodation in the car.

The requirements for the "S S" ship altered somewhat and it became desirable that the ship should be capable of landing on the water and also suitable for being towed from a seagoing ship. For this purpose the "Zero" type of car was designed and constructed at the Airship Patrol Station near Dover. No alteration of importance was, however, made to the envelope.

A ship larger again than the "Coastal" was found to be required for extended cruising in the North Sea and for work with the fleet, and the "N S" ship was therefore designed. She marks a distinct departure from the earlier classes. Her machinery is in a unit quite separate from the main car, which only carries the crew and navigating party. The gasoline carried by this ship amounted, under certain circumstances, to about 3 tons, and the distribution of this load constituted a very interesting problem. In the first ship it was carried in a number of tanks attached to either side of the top lobe at a convenient distance above the top ridges. Access to tanks was obtained through the gun tube, which passes up through the center of the ship, and then down a ladder-way to a walking-way along the top ridges. It was not, however, considered desirable that a man should have to be sent on top of the ship every time it was desired to turn on an additional fuel tank, and arrangements were made to lead wires from the power unit around the surface of the envelope to each individual tank. This method operated satisfactorily, but difficulty was experienced with the hose conveying the gasoline from the tanks to the car. The weight involved in the whole installation was also considerable. An alternative scheme was therefore designed and installed in the next ship. This provided large 90-gal. fuel tanks drawn up through the under surface of the envelope and suspended from the two top ridges by independent internal rigging generally similar to the main rigging. It is an interesting point that in the first few ships these tanks were made entirely of fabric lined with a special gasoline-resisting dope. Experiments on these tanks had been proceeding for a considerable time, and one tank had contained gasoline for over 12 months without serious loss of fuel or any apparent damage to the dope. It was found, however, after these tanks had been in use in several ships that an alteration in the constituents of the gasoline had included something which gradually softened the dope and caused cracking and leakage. As it was probable that further alterations in the gasoline might be made as the war proceeded, it was decided to be desirable to substitute aluminum tanks for these fabric ones, and metal tanks were therefore substituted in all later ships.

The development of the rigid airship shows fewer obvious features, although it may certainly be claimed that the improvements in strength and details of construction have been very satisfactory. The most obvious change has been with respect to the main keel of the ship. This keel, it will be remembered, has primarily to distribute the loads carried by the ship to the main transverse frames of the hull. In the earlier ships, as was the case in Germany, this keel was an external one of triangular section. Our next development was to eliminate the distinctive keel altogether, while in the "33" class the keel has returned but as an integral part of the structure. It will be seen that with a rigid airship it is possible to provide spacious accommodation both in the engine cars and in the navigating cars. It is possible for a mechanic to walk all around his engine and except for certain parts below the level of the crankshaft the whole of the machinery is as accessible as can possibly be wished.

In addition to the space in the cars there is ample space along the whole length of the keel for the stowage of fuel tanks, bombs, or any other form of gear which may be carried. Scarcity of space for the stowage of articles or passengers carried is a difficulty which in no way enters into the airship problem.

I will, in one respect, depart from the restriction I imposed upon myself at the beginning of the lecture and will point out where it will be most convenient to stow articles carried in airships of future types. It is considered probable as a result of experience that the non-rigid should, in future, be of circular section. This is primarily because of the difficulty of adjusting and examining the internal rigging of the "Astra" type. This internal rigging is necessitated only by a concentration of load, and if this concentration can be avoided the extra complications should not be incurred. The loads carried are most conveniently disposed inside the ballonets and can be carried by the fabric itself without any form of rigging whatsoever.

A further advantage from the pilot's point of view is that the position of the load or the air which replaces it when discharged does not vary and the trim of the ship is not affected.

Airship Handling

Certainly one of the most interesting parts of airship engineering is connected with the handling of ships when they are not in flight. The problem of anchoring, mooring, towing, moving them over the landing ground into the shed, or securing them in temporary shelter, is one calling for as much resource and ingenuity in development as the construction of the ships themselves.

An airship, as you all know, makes her landing by flying slowly up to a landing party collected on the ground. She drops her trail rope, which is taken by the landing party, led through a pulley block secured to the ground and then used to haul the ship down until she can be taken in hand by the party. A number of guys, led from suitable points along the length of the ship, are then manned by detachments of the landing party, and the ship secured in this way can be moved about in any direction. This operation presents little difficulty so long as the ship is kept carefully head to wind. The direction of the length of the shed is, however, fixed and it may well happen that the wind is blowing across the entrance to the shed. Under these circumstances it is necessary to turn the ship broadside to the wind to get her into the shed. The process of entering the shed offers very considerable difficulty. A sideways force on the ship is many times greater than that due to the same wind truly end on. In the neighborhood of the shed the wind is very seriously disturbed and forms large eddies. In many cases wind screens have been erected to break the force of a wind across the mouth of the shed, but it appears very probable that the unsteady flow produced by these screens renders the ship more difficult to handle than she would be if no screens at all were provided. To decrease the disturbance caused by these screens certain of them have been constructed with large gaps left at intervals, and others have been covered with expanded metal instead of corrugated sheets. Both these devices tend to reduce very greatly the eddies formed by the screens.

The difficulty in handling the ship appears to be very largely due to gusts and variations in the strength of the wind and also to the vertical component which the wind may have derived from its motion over sheds or screens and which tends to drive the ship down on the ground.

Present opinion appears to incline to a complete absence of wind screens and the provision of side rails and travelers to which the guys of the ship can be attached. The difficulty of taking ships into their sheds must not, however, be unduly magnified. Ships working at patrol stations have frequently been taken into their sheds in winds of 35 miles per hr. Winds such as this would, of course, cause considerable risk to a rigid ship of the largest type.

Mooring

Shortage of materials and the delays in shed construction rendered it necessary that to provide the great increase of airship bases required for the anti-submarine campaign, temporary arrangements should be made for mooring out the smaller airships. A very satisfactory means of arranging this was found by selecting suitable woods and cutting in them alleys leading up to small cleared space in which airships could be secured and protected from the wind by the trees. As long as trees of sufficient height were available it was found that this system proved most satisfactory, and many small mooring-out camps were established and satisfactorily protected their ships against winds of over 60 miles per hr. The size of ships which can be protected in this way is, of course, limited by the height of the trees. Other arrangements for mooring ships are therefore necessary.

The most obvious method of securing a ship to the ground is to attach her by a wire led from a suitable point in the ship to a fixed point on the ground. When secured in this way, it is found that an airship requires constant attention and steering to render her reasonably steady. It is found that considerable improvement is obtained by adding to the wire a dragging weight, or when secured over the water a drogue, which will, to a considerable extent, check, although not rigidly resist, the lateral motion of the bow of the ship. Variations in wind force are satisfactorily taken up by trimming the ship so that she lies at a small upward pitch. Any increase in wind force then causes an increase in her lift quite adequate to balance the increase in her resistance.

An improvement on this single-wire system consists in securing the mooring point of the ship to the head of a pyramid formed by three long wires. The lift of the ship raises these wires off the ground, and if she is given a slight upward pitch she is able to resist the action of a steady wind. This system has proved very satisfactory.

In both the foregoing systems there is considerable difficulty in changing crews or pumping water or gas into the ship. A much more convenient arrangement is made by securing the ship to the head of a comparatively short mast. Two methods of doing this have been proposed. The most obvious one is to secure the ship by her extreme bow point. This is a simple matter in the case of a rigid ship, but a non-rigid requires reinforcement at the bow.

Towing

The first towing experiment was carried out in 1912 when one airship broke down and was towed home by another. The towing ship landed alongside the disabled one and a wire was taken from her to a suitable point on the latter. The ships then rose and no difficulty was experienced in the towing operation. This operation in itself has not been used since, but it offers attractive possibilities for conveying large weights of material at a comparatively slow speed when the airship tug may tow a number of air barges after her.

The principal use which has been made of towing during the war is to tow an airship from a light cruiser or patrol boat. This operation in itself presents no serious difficulties. The ordinary trail rope forms a satisfactory

tow line, but it is absolutely necessary that the airship should be continuously steered while in tow. It has often been suggested that an airship which could be towed without its crew would be of considerable value. Although such a process is possible with a kite balloon, the airship which possesses considerably less directional stability and also has not automatic gear for maintaining the pressure would have to be radically altered before she would be suitable for towing empty. If altered so as to be stable enough to tow without crew, she would scarcely be satisfactory for ordinary flight.

Anchors

The problem of anchoring a ship or securing her without the assistance of men on the ground, is one which is mainly of importance if it is necessary to prevent an airship drifting when broken down. Various forms of grapnel have been used from free balloons for many years, but an airship which is many times heavier is found to acquire such momentum when drifting that she will pull out or break any ordinary grapnel. The problem of getting hold of the ground from an airship above it is much more difficult than appears at first sight. An ordinary grapnel will be dragged a considerable distance before it catches a tree or anything giving a suitable hold. A proposal was made many years ago that the airship should fire a form of harpoon into the ground and ride to that as an anchor. This question was again raised in 1916 and rough designs were therefore prepared to determine the best form of harpoon which would sink into the ground and then open so as to exert considerable resistance to being pulled out. The principal difficulty lay in obtaining sufficient penetration, and experiments were therefore carried out to determine the form of head which would give the best penetration. Several samples were dropped, and at the conclusion of the tests attempts were made to pull the dummy anchors out of the ground. This proved a very difficult business, and the idea of a solid grapnel which would penetrate the ground sufficiently far to jamb itself securely, obviously presented itself. Considerable success was obtained. The head of the anchor was made of cast iron with a long tubular shaft, and the wire was secured to a point close under the head. When this anchor had penetrated the ground to a considerable distance and the ship had drifted so that the pull became fairly oblique, the wire cut into the ground and tended to pull the whole grapnel sideways. To such an action a very satisfactory resistance was obtained. It was still, however, found that a heavy ship drawing her trail rope suddenly taut against a grapnel such as this, either parted the trail rope or ran considerable risk of damage to the mooring point of the ship. It was, therefore, necessary to devise some suitable means of gradually absorbing the energy of the drifting ship without producing any excessive impulsive tension on the rope.

The problem of anchoring over the sea is a comparatively simple one. An ordinary drogue, formed much like a parachute, has quite a satisfactory effect in reducing the speed of a drifting airship down to 2 or 3 knots. It was thought that if an anchor was dropped so as to be on the farther side of the drogue, the anchor would secure itself satisfactorily to the bottom of the sea and the drogue would then act as a weight to resist the upward component of the pull of the ship. Under these circumstances, however, it is found that the drogue has a considerable tendency to pull out of the water. A drogue which is kept moving through the water can easily be arranged to keep itself full. It is not easy to pull a drogue such as this out of the watr when it is desired to get under way again, and a slip has, therefore, been arranged whereby the drogue is secured to the end of the trail rope and can be slipped from the ship.

It is hoped that what has been given will suffice to show how far airships approach the completeness with which seagoing craft can be anchored and handled. There is, however, one important point to which it is desirable to draw attention in connection with the development of large aircraft. It is often advanced as a handicap inseparable from the airship that she requires a large handling party. When all things are considered for aircraft carrying the same disposable load the advantage appears rather to be with the airship. An airship, however large she may be, can be landed with as little difficulty as can the smallest airship. She can be brought slowly over the landing party and can be taken in hand on any ground which is reasonably free from obstruction. She can then be made considerably lighter than the air she displaces so that the force which the landing party has to exert is mainly a downward one. Provided the airdrome is clear and the surface good enough for the landing party to walk over, the ship can then be carried into her shed.

Compare this with the large airplane which must necessarily have a considerable horizontal velocity at the time it touches the ground. It must have a clear space of smooth, hard ground to run for a considerable distance, and when it has come to rest it presses on the ground with the whole of its total weight. Under these circumstances its handling over any but the most carefully prepared ground is a matter of considerable difficulty. The difficulties connected with landing and handling an airplane on the ground will, it is considered, increase very rapidly with size, and the margin in favor of the airship is likely to increase rather than decrease.

Airship engineering is a science which those who have experience in it realize to be at least as complex and involved, but also to have at least as great possibilities, as the corresponding airplane work. hTe man who knows much more about the airplane than the airship must realize that his view is distorted, while everyone, if he wishes to gage the relative possibilities of heavier-than-air and lighter-than-air craft, must remember that although the airship started first, the energy and talent devoted to its development have been incomparably less than those from which the airplane has benefited, more particularly in very recent times. One must be careful in comparing two things at widely different stages of development.

Standards Committee Meeting

THE Standards Committee of the Society held a meeting on June 23 to pass upon the work accomplished by its Divisions since the Annual Meeting held at New York City last February. Chairman B. B. Bachman presided and consideration was given to thirty-three recommendations submitted by the Electrical Equipment, Iron and Steel, Lighting, Miscellaneous, Motorcycle, Stationary Engine and Lighting Plant, Tire and Rim, Tractor, Transmission and Truck Standards Divisions.

The reports as finally accepted by the Committee and presented to the meeting of the Society on the evening of the same day are given below, together with the discussion at the meeting of the Standards Committee. Where any changes were made at the Committee meeting in a report submitted by a Division, such changes are enclosed in brackets at the end of the accepted report.

These reports, having been approved by the Standards Committee, the Council and the Society at the Semi-Annual Meeting, are to be submitted to a letter ballot of the voting members before they are officially adopted as Standards or Recommended Practices of the Society. The letter ballot for the mail vote has been sent out and the members should, in voting, refer to the following report.

Electrical Equipment Division

(1) *Rating of Storage Batteries—Electric Lighting Plants*

With the growth of the farm lighting plant industry, the desirability of establishing standard ratings for batteries in this service was taken up with the Society, as it was not felt that the customary methods of rating batteries by the 8-hr. or other short discharge period ratings indicated the capacity of the battery under its normal service condition. The subject was therefore assigned to the Electrical Equipment Division and a Sub-Division thereof was formed with a representative personnel of battery and lighting plant manufacturers. At a meeting held in Indianapolis, the proposed standard was carefully worked out and presented to the Electrical Equipment Division for consideration. The Division, after making some slight changes in the proposal, now offers the following recommendation for adoption as S. A. E. Standard:

The standard battery ratings shall be established at a standard (initial) temperature of 80 deg. fahr.

The rated capacity of storage batteries for farm lighting service shall be based on a final voltage of not less than 1.75 volts per cell for lead batteries.

The period of elapsed time at which the rated ampere-hour capacity is available shall be definitely stated.

In rating farm lighting batteries, the maximum available capacity that can be obtained intermittently or over prolonged discharge periods shall be limited to that obtainable over a period of 72 hr.

The standard test shall be at a rate of one-twenty-fourth of the ampere-hour capacity of the battery for an initial period of 4 hr., followed by a 16-hr. rest; and then by two 8-hr. periods, each followed by a 16-hr. rest. After the last rest the final discharge period shall be 4 hr.

All of the above is applicable to nickel-iron batteries, except the final voltage per cell, which applies to lead batteries only. The short periods at the beginning and at the end of the test permit it to begin at noon of the first day and end at noon of the last day.

[It was voted at the Standards Committee meeting to omit the sentence "The capacity which can be obtained over a continuous discharge period of 8 hr. shall be stated" from the report as originally submitted by the Division]

The Stationary Engine and Lighting Plant Division concurred in this report and L. S. Keilholtz, chairman of that Division, so reported.

THE DISCUSSION

G. M. GARDNER:—There seems to be a disposition on the part of some manufacturers to object to the intermittent rating or to the 8-hr. rating which has been standard. They feel, and this applies more particularly to the lighting plant manufacturers, that to standardize two ratings would create confusion in the minds of the ultimate purchasers of farm lighting plants.

GEORGE E. TUBBS:—We feel that whichever rating is desirable should be adopted as a standard, rather than adopting two standards. When you talk to the farmer about this, he says, "What are you going to have?" We feel that the thing to do is to have one explanation, doing away with one of the two propositions.

L. S. KEILHOLTZ:—I believe that most of the lighting plant manufacturers would be willing to eliminate the 8-hr. rating, which was included in our report at the suggestion of battery manufacturers. I believe the 72-hr. rating is the one that will be used by all the lighting plant people. The 8-hr. rating has been used in general by a number of battery manufacturers, but there has been no standardization of it by any society or the Government.

W. H. CONANT:—The 8-hr. rating for a storage battery is not established by agreement but by practice extending over many years. There are reasons for using it for comparative purposes. The storage battery manufacturers represent a gradually acquired amount of knowledge and experience. I believe the hardest thing in the automobile line to make clear to the public is the capacities, the capabilities of storage batteries when reduced to terms of service. For this class of work the 8-hr. rating would seem to apply to any battery because every manufacturer of batteries knows what you mean when you say such and such capacity, and you will get much better uniformity of product.

I. M. NOBLE:—I do not believe this is a matter for decision by the storage battery people. It is true that the 8-hr. rate has been long established by practice, but I believe it is not definitely written down as a standard adopted by any society. We battery manufacturers give the 8-hr. capacity of the battery and can immediately arrive at what should be any other time capacity, either 3 or 72 hr. The public in general, however, is not capable of doing that. It seems to the storage battery manufacturers that the 72-hr. rating gives to the ultimate purchaser the impression of greatest promise of capacity for his money. It does not seem quite rational to us, but it is entirely a matter for the farm lighting plant people to decide. If they tell us they want a capacity of 72 hr., we will know exactly what to furnish them. If they say

8 hr., we will know just as well. It is a question of satisfying the user as I see it.

H. S. GARDNER:—An effort has been made recently, and is meeting with some success, to form an association of the manufacturers of lighting plants. That embraces the manufacturers of the four principal units entering into a lighting plant, batteries, generators, switchboards and engines. I believe it would be proper to refer this question to that association. It will include manufacturers making in excess of 75 per cent of the lighting plants sold in the country.

MR. KEILHOLTZ:—This association is a section of the National Gas Engine Association, which is strictly a commercial organization. The standards are being handled by the S. A. E. The battery manufacturers and the lighting plant manufacturers have had an opportunity to comment on this rating matter, which has been very thoroughly discussed by a Sub-Division and two Divisions of this Committee.

MR. TUBBS:—As I understand it, the Sub-Division that met at Indianapolis was not representative of the farm lighting industry, and since that time there has been considerable discussion as to what a proper standard would be. A number of the manufacturers feel that they should have further chance to go into the subject and determine what would be a workable arrangement.

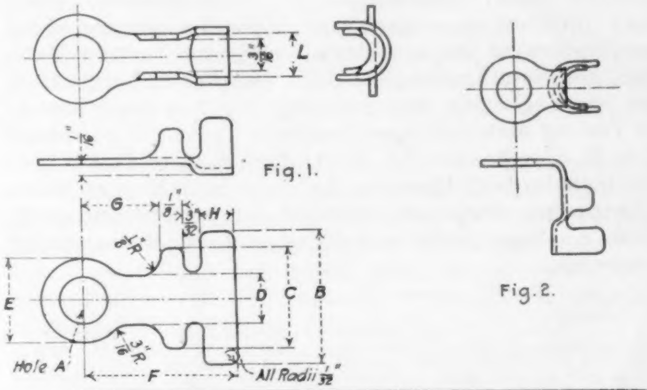
CHAIRMAN BACHMAN:—The companies whose representatives were present at the Indianapolis meeting on May 28 were the Electric Storage Battery Co., Willard Storage Battery Co., Domestic Engineering Corporation, Prest-O-Lite Co. and U. S. Light & Heat Corporation. Those who were invited to but did not send representatives were the Edison Storage Battery Co., the General Gas Electric Co., the Alamo Farm Lighting Co. and the Lally Light Corporation. Those were the companies requested to cooperate in preparing this specification. A proposed rating for this class of battery was discussed from testing, sales and operating points of view, as to what would constitute a satisfactory method of indicating capacities which would be desirable for this class of service. The recommendation of the Sub-Division was discussed the following day at a meeting of the Electrical Equipment Division, with several members of the Sub-Division in attendance. It was explained that the recommendation was made in accordance with the practice of most larger lighting plant manufacturers. The Sub-Division report was amended to include specific discharge periods and was approved by the Electrical Equipment and the Stationary Engine and Lighting Plant Divisions. It is the intention of the Society to cooperate to the fullest extent with the National Gas Engine Association and the lighting plant manufacturers. The Division members have conducted their work carefully and believe they have arrived at a satisfactory result.

[In answer to a question, Mr. Keilholtz explained that by dividing the 72-hr. rating by 24, the number of actual discharge hours in the proposed standard test, gives the discharge in amperes]

(2) *Cable Terminals for Generators, Switches and Meters*

Last year the Division presented for adoption specifications for cable terminals for starting motors printed on page 36e, S. A. E. Handbook, Vol. I.

There were, however, so many types and sizes of terminals for generators, switches and meters that it was believed that a standard for these would be of value to the industry. The Division therefore recommends for S. A. E. Standard the cable terminals given below:

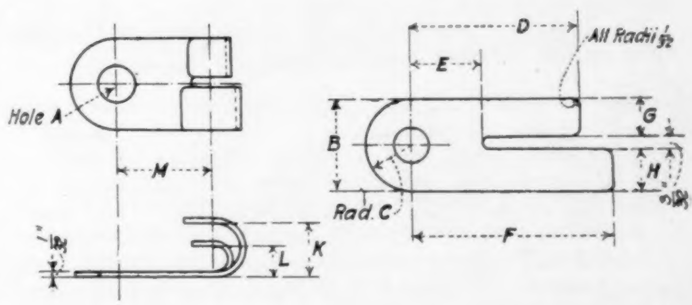


Terminal Stud Sizes	Dia. of Hole	B	C	D	E	F	G	H	L	Thick.
No. 8 (0.1640")	0.171	11/16	15/32	7/32	3/8	3/4	3/8	5/32	7/32	0.031
No. 10 (0.1900")	0.201									
No. 14 (0.2420")	0.2570	23/32	17/32	1/4	15/32	13/16	13/32	3/16	1/4	0.040

Material—To be Specified by User.

*NOTE:—The Terminals as Formed in Fig. 1. may also be Formed as shown in Fig. 2.
These Terminals are not intended for Use on Ignition Distributors.*

SPADE-TYPE CABLE TERMINALS



Terminal Stud Sizes.	Dia. of Hole.	B	Rad. C	D	E	F	G	H	K	L	M
No. 8 (0.1640")	0.171	3/8	3/16	19/32	5/16	3/4	1/8	5/32	5/32	5/64	11/32
No. 8 (0.1640")	0.171	13/32	13/64	43/64	5/16	27/32	1/8	3/16	3/16	3/32	3/8
No. 10 (0.1900")	0.201										
No. 14 (0.2420")	0.2570	1/2	1/4	27/32	3/8	1 3/32	3/16	7/32	1/4	1/8	1/2

Material—To be Specified by User.

NOTE:—These Terminals are not intended for Use on Ignition Distributors.

SIDE-TYPE CABLE TERMINALS

(3) *Barrel Mounting for Starting Motors*

A revision of the present Recommended Practice for Barrel Mounting for Starting Motors (See page 36da, S. A. E. Handbook, Vol. I) is recommended by the Division.

This revision consists in providing definite limits for the gear location of the starting motor with respect to the flywheel, a pitch line clearance of 0.015 to 0.025 in. instead of 0.015 in. being recommended.

Iron and Steel Division

(4) *Screw Stock*

The Division has prepared and recommends two types of screw stock; Specification No. 1112, Bessemer screw stock identical in composition with the corresponding specification[1] of the American Society for Testing Materials, and Specification No. 1120, open-hearth screw stock also identical with the corresponding American Society for Testing Materials specification.[1] These will supersede S. A. E. Specification No. 1114 which is of a blanket type that includes both Bessemer and open-hearth screw stock.

These two steels are intended for general automatic screw machine products not requiring more particular properties.

S. A. E. Specification No.	Carbon	Manganese	Phosphorus	Sulphur
1112	0.08 to 0.16	0.60 to 0.80	0.09 to 0.13	0.075 to 0.15
1120	0.15 to 0.25	0.60 to 0.90	0.06 maximum	0.075 to 0.15

[1]No. A-29-18.

(5) *Chromium Steels*

The Division recommends eliminating S. A. E. Specifications No. 5195, 51120 and 52120. It also recommends changing the chromium limits of Specifications No. 5120, 5140 and 5165 from 0.65 to 0.85 per cent with 0.75 per cent desired to 0.60 to 0.90 per cent with 0.75 per cent desired. The Division also recommends eliminating Specification No. 5295, replacing it by Specification No. 52100 with the analysis given below.

These changes consist in eliminating the steels that do not appear to be necessary; replacing them with one fully representative type of oil-quenching steel.

The S. A. E. Standard for chromium steels as thus revised by the Division is as follows:

S. A. E. Specification No.	Carbon		Manganese		Phosphorus (Maximum)	Sulphur (Maximum)	Chromium	
	Minimum and Maximum	Desired	Minimum and Maximum	Desired			Minimum and Maximum	Desired
5120	0.15 to 0.25	0.20	[2]	[2]	0.04	0.045	0.60 to 0.90	0.75
5140	0.35 to 0.45	0.40	[2]	[2]	0.04	0.045	0.60 to 0.90	0.75
5165	0.60 to 0.70	0.65	[2]	[2]	0.04	0.045	0.60 to 0.90	0.75
52100	0.95 to 1.10	1.00	0.20 to 0.50	0.35	0.03	0.030	1.20 to 1.50	1.35

[2]Two types of steel are available in this class, one with manganese 0.25 per cent to 0.50 per cent (0.35 per cent desired), and silicon not over 0.20 per cent; the other with manganese 0.60 per cent to 0.80 per cent (0.70 per cent desired), and silicon 0.15 per cent to 0.50 per cent.

(6) *Nickel Chromium Steels*

The Division recommends the following changes in S. A. E. specification numbers. It is believed these changes will avoid future confusion and misinterpretation in telegraphic communications and general correspondence.

Present Specification No. X3315 to be changed to No. 3415.

Present Specification No. X3335 to be changed to No 3435.

Present Specification No. X3350 to be changed to No. 3450.

(7) *Tungsten Steels*

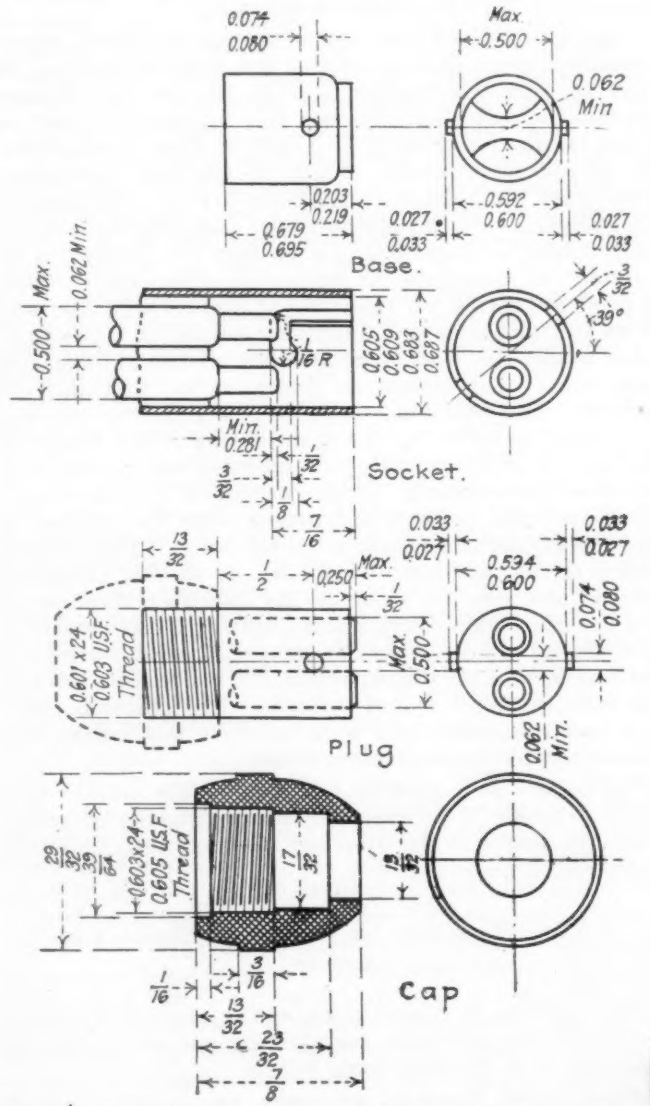
The Division recommends the adoption of two tungsten steels, the analyses corresponding closely to Signal Corps Specifications W60 and W60A. These specifications provide suitable high-tungsten steels for exhaust valves.

S. A. E. Specification No.	Carbon		Manganese (Maximum)	Phosphorus (Maximum)	Sulphur (Maximum)	Chromium	Tungsten
	Minimum and Maximum	Desired					
7060	0.50 to 0.70	0.60	0.30	0.035	0.035	3.00 to 4.00	12.00 to 15.00
7160	0.50 to 0.70	0.60	0.30	0.035	0.035	3.00 to 4.00	15.00 to 18.00

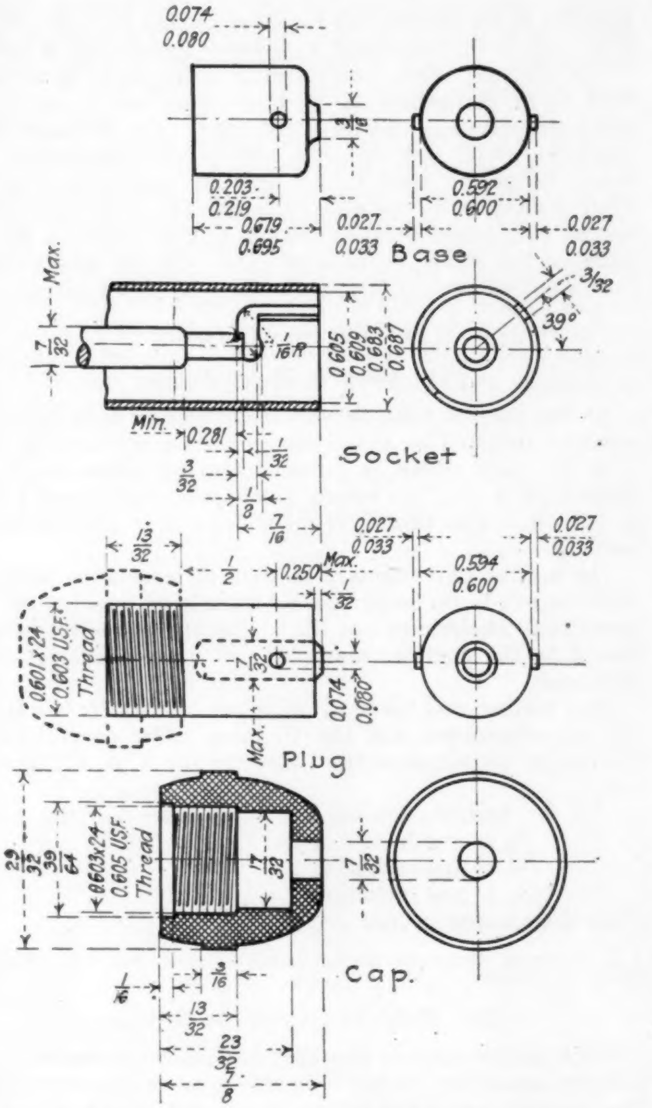
Lighting Division

(8) *Bases, Sockets and Connectors*

The Division recommends for adoption the following specifications for bases, sockets, plugs and caps for insulated and ground return systems. These specifications incorporate the present S. A. E. Standards for Electric Bulbs for Ground and Insulated Return Systems given on pages 38 and 38xa, S. A. E. Handbook, Vol. I. These revisions will bring the S. A. E. Standards in line with present practice and make them more complete by including essential dimensions not previously standardized.



Electric Base, Socket, Plug and Cap for Insulated-Return System



ELECTRIC BASE, SOCKET, PLUG AND CAP FOR GROUND-RETURN SYSTEM

M. W. Hanks in presenting this recommendation said that it would be impossible to do anything with the general headlamp illumination problem unless the location of the filament was controlled with accuracy. To do this it is necessary to place limits on the manufacturing dimensions of the sockets and of all the parts which are involved in the location of the filament. These various dimensions with the tolerances recommended are given in the accompanying drawings.

(9) *Focusing Lengths of Incandescent Lamps*

In presenting the report on this subject, M. W. Hanks, chairman of the Division, said that heretofore we have had in our specifications a focusing length of $1\frac{1}{4}$ in. but no tolerance had been placed on this dimension. Manufacturers have felt that limits should be placed on the location of the filament so as to get better control of the light beam. As a result of its investigation the Division worked out the following tolerances:

Deviation of filament field along axis of base............	$\pm$ 3/32 in.
Deviation of filament field at right angles to axis of base.	$\pm$ 5/64 in.

It is recommended that the above deviations be reduced by the incandescent lamp manufacturers so that the allowable deviation from the axis of the base is no greater than one-half of the base of the filament field for any type of incandescent lamp.

THE DISCUSSION

F. C. GOLDSMITH:—I would like to ask if this permits placing the filament in the center of the bulb, the bulb being built in accordance with the wattage. One other point is also important. If the filament is in the center of the bulb it will give a better radiation of heat as well as better light. Does the same rule apply to heat as to light?

M. W. HANKS:—I think that is a very good point because there is a tendency to overwork that portion of the glass nearest the filament. I understand that the lamp manufacturers plan considerable development work on the shape of the bulb itself, with special reference to getting rid of reflected light and presumably with regard to getting more uniform heat radiation.

MR. GOLDSMITH:—This was markedly shown in connection with some headlamp work I was connected with. The lamp manufacturers moved the filament back with relation to the bulb and found that the life of the lamp was shortened very materially.

MR. HANKS:—With this $1\frac{1}{4}$-in. filament location a lamp can be designed with the filament more nearly in the center of the bulb itself. A point was brought up about the location of the filament in the bulb. I talked with Mr. Bauder, who told me that the location of the filament is receiving considerable attention among the lamp manufacturers at the present time, because when the filament is placed in a position other than the center of the bulb, the glass in the bulb itself throws extra light into the parabolic reflector and tends to make the control of the beam difficult. Mr. Bauder stated that the proposed location of the filament will be satisfactory for new designs and the glass itself.

(10) *Lens Sizes*

That the present number of lens sizes seems entirely too great for economic conditions, was stated by Mr. Hanks, chairman of the Division, in presenting the report on this subject. It means excessive stock in the hands of garage men, dealers and manufacturers. The Sub-Division which was assigned to this subject concluded, after a thorough investigation and review covering some eighty or ninety different sizes and also thoroughly analyzing present popular sizes, recommended that the lens sizes with the tolerances given be adopted as S. A. E. Standard.

Outside Diameter of Lens, in.	Diameter of Prism Area, in.
8 5/32 $\pm$ 1/32	$6\frac{7}{8}$ $\pm$ 1/32
$8\frac{1}{2}$ $\pm$ 1/32	$7\frac{1}{4}$ $\pm$ 1/32
9 $\pm$ 1/32	$7\frac{3}{4}$ $\pm$ 1/32
$9\frac{1}{2}$ $\pm$ 1/32	$8\frac{1}{4}$ $\pm$ 1/32

Thickness of bezel edge for all sizes is to be $\frac{1}{8}$ in., plus 1/32, minus 0. This is commonly known as double thick American glass.

The proposed standard is to become fully operative by July 1, 1921.

[The tolerance for outside diameter of lens was reported to the Standards Committee as +1/32, —0. This was a typographical error, the report as given above conforming with the recommendation of the Division]

THE DISCUSSION

M. W. HANKS:—One point should be brought out here, I think, and that is why the smallest size should be 8-5/32 instead of an even 8 in. The lamp manufacturers,

who are most interested in this proposed standard, considered it wiser to standardize 8-5/32 in. for the smallest size, because of its tremendous popularity and in order to create the least disturbance from a production standpoint.

E. E. SWEET:—It seems to me that inasmuch as this recommendation is not to become fully effective for 2 yr., it would be well to eliminate that 8-5/32-in, size and make it 8 in.

MR. HANKS:—In connection with Mr. Sweet's comment, I wish to say that I wanted to see regular, definite increments. Commercially, when you start out on standardization work you make a sort of gun-shot target of popular sizes and find there are little puddles of shots here and there. You draw a ring around them and say "Those will be our standards." That is rather easy, but does it mean good engineering standards? It is all right for a commercial organization to standardize that way, but I think that for the S. A. E. to do so is not quite up to its standard method. At the same time we must not lose sight of the fact that there is a very heavy demand for the 8-5/32-in. size.

MR. SWEET:—It seems that inasmuch as we are not responsible for any standards along that line up to this time, we should drop the fraction from that size.

E. H. EHRMAN:—Is not one of the fundamentals the idea of coordinating the most prevalent practice? I would like to cite an example in the standardizing of fire hydrant connections, in which there was an equal division between 8 and 7 threads per in. on the 2½-in. size. The recommendation of 7½ threads per in. was a compromise for the purpose of unifying the entire system, not with the idea of getting out a new perfect system which could not be put into service for a great many years and which would really add a third system rather than eliminate one of the existing systems. Further than that, is it necessary that the increments be uniform throughout the entire series? In the recommendation before us the first increment is slightly less than the next. The smallest size is entitled to a smaller increment. The size of the increment is progressive, the larger increment for the larger sizes and the smaller increment for the smaller sizes. Therefore I see no harm in approving the standard proposed by the Division.

W. H. CONANT:—There is no divergence of views among the lens manufacturers, I believe, and none among the manufacturers of headlamps. They would like to reduce the number of sizes. The ones primarily interested are the lamp manufacturers. The automobile builders and the lens manufacturers are willing to follow any agreement that can be reached by the lamp manufacturers. This list is the result of such agreement. I think it behooves the rest of us to endorse it promptly and to thank lamp manufacturers for the compromises which they have made among themselves to make this exceedingly small list possible. I therefore urge the committee strongly to approve the recommendation of the Lighting Division.

F. C. GOLDSMITH:—Fixing the focusing length of a bulb means that the focusing length with respect to the reflector is fixed. That being the case, the greatest intensity will be in the center of the beam. Very little benefit is derived from the light which is reflected from the outer curves of the parabolic reflector. There is very little difference in light with an 8-in. or a 9-in. size. It merely means continuing the depth of the reflector to get the difference in the diameter. I would like to have this subject referred to passenger car builders to see if it is not possible to standardize on fewer sizes, say an 8 in. and a 9 in. A ½-in. increment is a small amount on a lamp.

MR. HANKS:—Mr. Goldsmith is quite right in saying that ½-in. difference in diameter does not make very much difference in the light reflected. The Division appreciates that, but from a commercial standpoint it would be pretty hard to get the car manufacturers to limit themselves to one size. I believe the small sizes cannot be eliminated because the car builders want a small lamp on the small inexpensive cars. On the larger cars they want something distinctive and in larger sizes.

MISCELLANEOUS DIVISION

(11) *Flexible Metal Tubing*

At the present time flexible metal tubing is in general practice supplied to the trade in diameters varying by 1/32 in., and closer in some cases, for sizes ranging from ¾ to 4 in. The tubing thicknesses vary from 1/32 to 1/16 in. The tubing is made both with and without packing.

The lack of any standard method of measuring tubing with respect to its being twisted tightly or loosely and in specifying whether or not the inside or outside diameter should be the nominal diameter has caused considerable confusion.

This matter was taken up with the Society by the tubing manufacturers, and the Division, after careful consideration, recommends the following for S. A. E. Standard:

[3]Outside Diameter	Sizes Vary by
¾ to and including 1½	1/16
1⅝ to and including 2½	⅛
2¾ to and including 4	¼

All dimensions in inches.

[3]As received from the tubing manufacturers and not twisted tightly or loosely.

(12) *Hub Odometers for Trucks*

Work on this subject was first considered in connection with the mounting of hub odometers on military trucks. The present recommendation is an outgrowth of this work and is for commercial truck application.

It is not felt that a standard can be carried beyond the actual housing dimensions, the method of locking the instrument into the case and the drive method and dimensions. There are several methods of drive in use, but the one recommended by the Division is common, of good design and open to use by anybody. The type set in from the outside is not considered desirable because of the ease with which it can be tampered with, stolen or injured.

The recommendation of the Division is incorporated in the drawing on page 181.

THE DISCUSSION

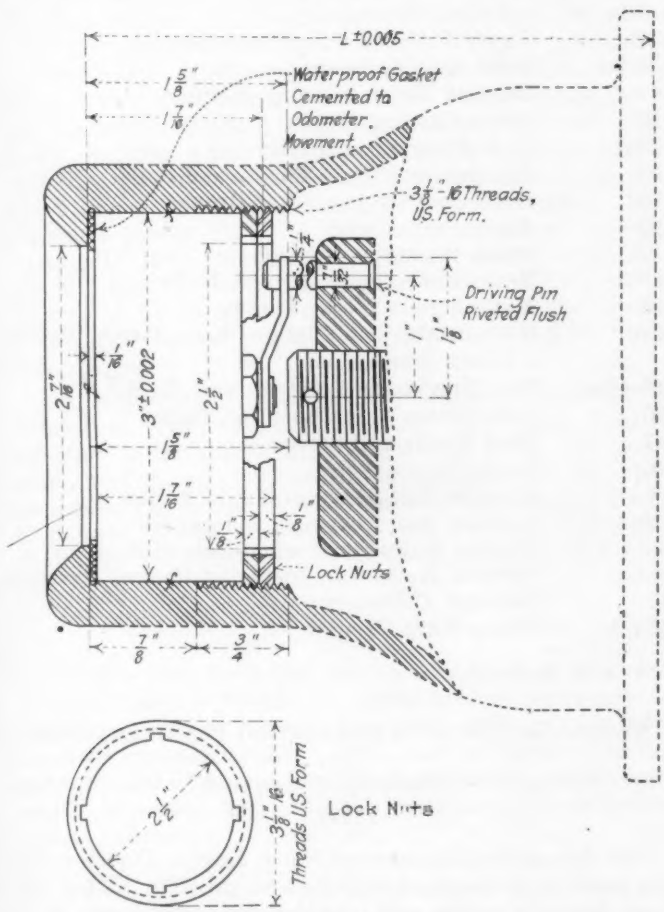
E. E. WEMP:—Any difference in the thickness of a wooden spoke will naturally affect the dimension 1⅝ in. to the driving member. I believe that the driving member should be extended inwardly so as to strike farther down on the pin and the pin should be cut off more so as to allow more clearance between it and the instrument. I do not know off-hand what the difference in spoke thicknesses is.

CHAIRMAN BACHMAN:—There is a ¼-in. clearance between the instrument cartridge and the end of the pin.

L. P. KALB:—I think Mr. Wemp is right in saying that with the pin rounded off on the end there is not enough

space allowed between the outside of the arm and the end of the pin. With the variation in spokes and take-up on bearings the driving arm is liable to slip off the pin if it gets out on the round instead of being a positive drive.

E. H. Ehrman:—This mechanism has been in practice for some time. It was developed during the war. The arm is flexible and is meant to be pressed down in assembling to the proper driving position on the pin. This mounting has been applied on various makes of vehicle and is very flexible. The arm is shown straight; that is square with the axis, but is made split or flexible so that it can be bent over to secure the desired engagement on the pin. That pin, as shown in the sketch in the report of the Division, was rounded off. It can be left flattened on the end with a chamfered edge.[4]



Proposed Standard for Hub Odometers for Trucks

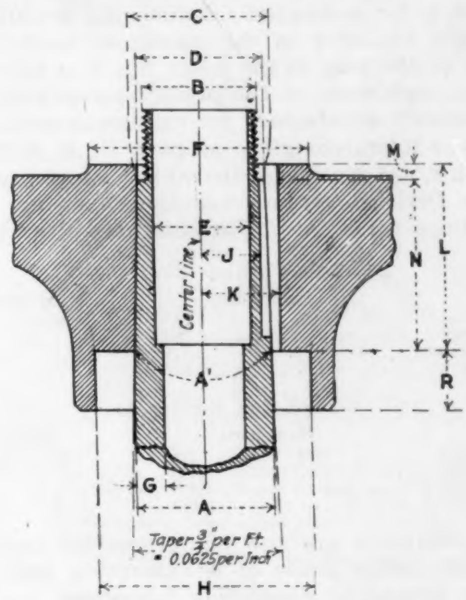
(13) *Steering-Wheel Hubs*

The Miscellaneous Division has been considering this subject for about two years and a half, but has not been able to present a recommendation before on account of the difficulties encountered in the work. After considering several preliminary recommendations, the Division has finally proposed the following for S. A. E. Standard.

The Division proposes the recommendation for S. A. E. Standard except that the key and threads are proposed for adoption as S. A. E. Recommended Practice until it shall be known definitely whether they are satisfactory for S. A. E. Standard.

The nut dimensions in the following table, which are submitted as general information only, allow for the proper seating of the nut on the pad (diameter F):

[4]This change has been made in the sketch given above, which has been redrawn in scale.



Proposed Standard for Steering-Wheel Hubs

Size No.	6	7	8	9	11
A	⅞	1	1⅛	1¼	1½
A'	0.870	0.994	1.118	1.242	1.490
B[5]	¾—20	⅞—20	1—20	1⅛—18	1¼—18
C	0.8075	0.9217	1.0360	1.1502	1.3767
H	1 9/16	1 13/16	1 13/16	2 1/16	2 5/16
F	1½	1¾	2	2¼	2⅜
L	1⅛	1 5/16	1 15/32	1⅝	2
M	⅛	5/32	5/32	5/32	3/16
N	1	1 5/32	1 5/16	1 15/32	1 13/16
R	⅜	7/16	½	9/16	⅝
D	0.7997	0.9120	1.0262	1.1404	1.3650
E	19/32	23/32	51/64	59/64	1 3/64
G	5/32	5/32	3/16	3/16	¼
J[5]	0.3569	0.4164	0.4552	0.5147	0.6333
K[5]	0.5444	0.6039	0.7052	0.7647	0.8833
Key Width[5]	0.1875	0.1875	0.2500	0.2500	0.2500

[5]S. A. E. Recommended Practice only.

STEERING-WHEEL NUT AND SEAT DIMENSIONS
(*For information only*)

Screw Size (S. A. E. Fine)	Wall	Short Diameter	Long Diameter	F
¾—20	5/32	1 1/16	1 15/64	1½
	¼	1¼	1 7/16	
⅞—20	3/16	1¼	1 7/16	1¾
	¼	1⅜	1 19/32	
1 —20	3/16	1⅜	1 19/32	2
	7/32	1 7/16	1 21/32	
1⅛—18	3/16	1½	1 47/64	2¼
	¼	1⅝	1⅞	
1¼—18	3/16	1⅝	1⅞	2⅜
	9/32	1 13/16	2 3/32	

All dimensions in inches.
All threads U. S. Form.

THE DISCUSSION

E. H. Ehrman:—I will add a few words with reference to the key-seating dimensions. At the middle of the key it was recommended to make the depth of the keyway in the steering column one-third of the key height and depth in the steering-wheel hub two-thirds of the height. The decimal values have been worked out since this report was printed.

Motorcycle Division

(14) *Spark-Plug Shells*

The Division recommends for adoption for S. A. E. Standard as motorcycle practice the ⅞-in. hexagon spark-plug shell and tapped hole dimensions and tolerances for the ⅞-in.-18 U. S. Form. thread given on page 3, S. A. E. Handbook, Vol. I.

Spark plugs 18 mm. in diameter, 1½-mm. pitch and

with the International Standard thread are used extensively in motorcycle practice. The dimensions of the hexagon are the same as those on page 3a, S. A. E. Handbook, Vol. I, for aeronautic recommended practice. There is a slight variation in the maximum reach from the shoulder of the plug to the point, but it is believed that the 5/8-in. maximum of the present recommended practice is entirely satisfactory for motorcycle work. As the tapped hole tolerances given on page 3b, S. A. E. Handbook, Vol. I, are considered too wide for motorcycle practice, the Division recommends the following complete specifications for S. A. E. Recommended Practice.

Spark-Plug Thread Dimensions

	Maximum		Minimum	
Diameter	Mm.	In.	Mm.	In.
Outside (full)	....	0.709	....	0.706
Pitch (effective)	....	0.670	....	0.667
Root (core)	....	0.626	....	0.623

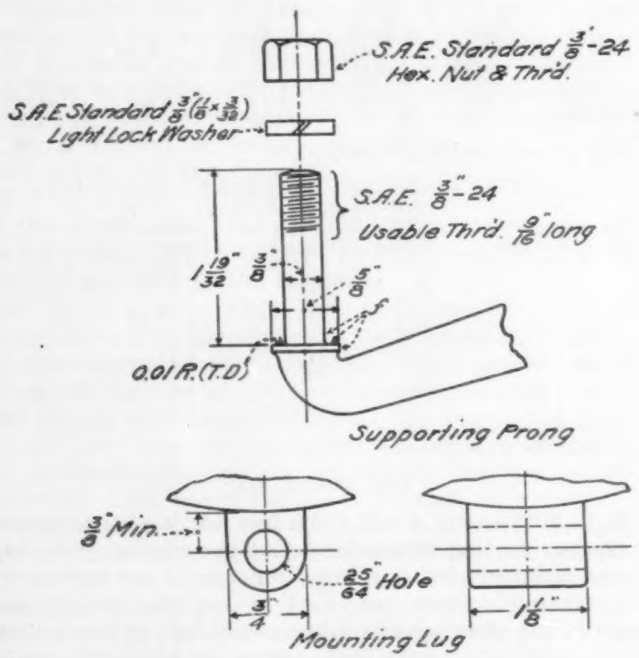
Tapped Hole Dimensions

	Maximum		Minimum	
Diameter	Mm.	In.	Mm.	In.
Outside (full)	....	0.719	....	0.717
Pitch (effective) ..	....	0.674	....	0.672
Root (core)	....	0.636	....	0.634

These tolerances are now being specified and require only a little better grade of workmanship than that in using the aeronautic spark-plug tolerances.

(15) *Head-Lamp Mounting Lugs and Supporting Prongs*

As the following has now become general accepted practice among motorcycle manufacturers, the Division recommends the adoption of this specification as S. A. E. Standard in place of S. A. E. Recommended Practice.



PROPOSED HEAD-LAMP MOUNTING

(16) *Motorcycle Chains*

The Division recommends for adoption the following chain specifications for S. A. E. Standard, superseding the present Recommended Practice for military motorcycles, as the specification has been generally adopted in commercial work.

Motorcycle driving chains shall be of the roller type with the following dimensions:

Pitch, 5/8 in.
Roller width, 3/8 in.
Roller diameter, 0.40 in.

(17) *Approval of Existing S. A. E. Standards*

The Division has reviewed the present Standards and Recommended Practices and the following are approved for motorcycle practice:

Page[6]	Subject
2b	Cotter-Pins
4	Screws and Bolts
4a	Screws and Bolts
4c	Screw Threads
7	Square Broached Fittings
7a	Taper Fittings
7d	4-Spline Fittings
7e	Taper Fittings with Castle Nuts
9-9d	Steel Specifications
11	Babbitt Metal, Bearing Metals
12	Brass Casting Metals
12a	Cast Manganese Bronze
12b, c	Manganese Bronze Sheets and Rods
12d	Hard Cast Bronze, Gear Bronze
13	Aluminum Alloys
13a	Brass Sheets and Strips
13b	Brass Rods, Tobin Bronze Rods
13c	Non-Ferrous Metal Tubing
14c	Nomenclature of Roller-Chain Parts, Roller-Chain Dimensions
15-15xd	Test Specimens for Iron and Steel
16	Cold-Drawn Seamless Steel Tubes
17	Steel Bands and Strips
26c	Brake Linings
29	Annular Ball Bearings, Light Series
29c	Annular Ball Bearings, Tolerances
38	Electric Bulbs for Ground-Return Systems
38xa	Electric Bulbs for Insulated-Return Systems
47	Oversize Cylinders
47a, b	Piston-Ring Grooves

[6] S. A. E. Handbook, Vol. 1.

STATIONARY ENGINE AND LIGHTING PLANT DIVISION

(18) *Voltage and Capacity Ratings—Electric Lighting Plants*

The former Stationary and Farm Engine Division felt the need of a standard voltage and capacity rating for farm lighting outfits and considerable preliminary work was done. It was not felt, however, that the recommendation which was agreed upon at that time represented the consensus of opinion of the industry, and the matter was therefore not brought up at the Standards Committee meeting in February 1919. The present Division, however has reviewed this work and presents for adoption as S. A. E. Recommended Practice the following voltage and capacity ratings for electric lighting outfits.

Electric lighting plant voltage and capacity ratings shall be according to the accompanying table:

Normal Generator Rating, kw.	Normal Voltage[7]	Engine and Generator Speed, r.p.m.
1/2	32	1200 or 1800
3/4	32	1200 or 1800
1	32	1200 or 1800
1 1/2	32	1200 or 1800
2	32 or 110	1200 or 1800
3	32 or 110	1200 or 1800
5	32 or 110	1200 or 1800

[7] 16 cells (lead batteries) for 32 volts and 55 cells for 110 volts.

THE DISCUSSION

L. S. KEILHOLTZ:—Engine manufacturers want to be able to purchase standard generators and for that reason the proposed Recommended Practice is presented.

G. E. TUBBS:—Mr. Keilholtz suggested that the table be modified and I suggest that the engine and generator speed be 1200 or 1800 r.p.m. and the last column omitted.

B. H. CHATTO:—In the column, Normal Rating in Kilowatts, it is not clear whether this is generator rating or combined battery and generator rating. The voltage, 32, is standard for the smaller sized plants at the present time. Going to 5 kw. we get to the point where 32 volts cannot be economically transmitted more than 200 or 300 ft. On a farm where we want to reach the more distant buildings, we should have 110 volts for the larger plants. Moreover, there are a number of manufacturers who are working on an automatic 110-volt plant for smaller sizes. I believe you will all agree that if the engineers can eliminate the uncertain features and get a satisfactory 110-volt plant, this will be very desirable. I also feel that a pretty big step is being taken in recommending only two speeds. Using a single-cylinder engine for 5 kw., as most plant manufacturers are doing, 1400 r.p.m. is pretty high. I think that ought to be 1200 r.p.m. If 1200 r.p.m. is all right for 5 kw., the speed would certainly be much higher than 1800 r.p.m. on ½ kw. I am in accord with Mr. Tubbs' opinion that it is not fair to the generator to call 1800 r.p.m. "high speed."

MR. KEILHOLTZ:—I think it would be satisfactory to substitute "electric lighting outfits" for "farm lighting outfits," to include 32 or 110 volts for 2-kw. and larger sizes, and to specify under "kilowatts" that this is a generator rating. A representative of the Electric Power Club, who is also a member of the Division, has stated that 1200 and 1800 r.p.m. are standard speeds and satisfactory.

(19) *S. A. E. Engine Testing Forms*

The Division feels that the present S. A. E. Standard Engine Testing Forms are suitable for stationary internal-combustion farm engine work, with certain additions which the Division recommends be included so that the forms can be used in either automobile or stationary engine practice. The additions and changes recommended are as follows:

Sheet A—No additions or changes.

Sheet B—(a)—Addition of "Normal Horsepower" after "Name and Model."

(b)—Addition of "Normal R.P.M." as Item No. 2a.

(c)—Addition of the sub-division "Cooling System" after "Lubricating System" with the following items:

Air-Cooled .... Water-Cooled { Radiator, Capacity, Gal....Lb....
Tank, Capacity, Gal....Lb....
Hopper, Capacity, Gal....Lb....

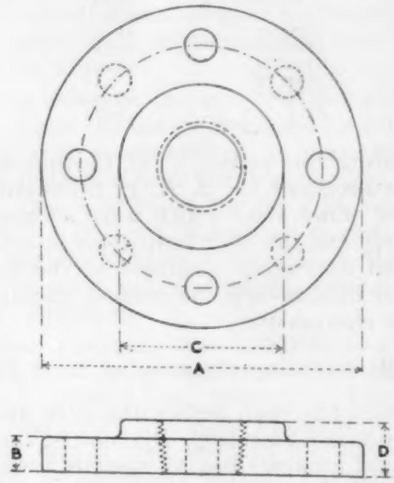
Sheet C—Addition of "Weight of Water Evaporated" after "Temperature of Jacket Water-Out" under "Brake Horsepower and Fuel Consumption" and "Friction Horsepower" subdivisions.

Sheet D—Addition of R.P.M. ordinates from 0 to 1300 above that part of the present ordinates reading from 200 to 2800.

It is understood that these additions will be marked so as to refer to footnotes on all sheets reading "For use with stationary internal-combustion farm engines."

(20) *Round Pipe Flanges*

This subject also was considered by the former Stationary and Farm Engine Division but no recommendation was submitted by it for the approval of the Standards Committee. The subject has been reviewed and this Division now feels warranted in presenting for adoption as S. A. E. Standard the following exhaust-pipe round flange dimensions:



ROUND EXHAUST PIPE FLANGE

Size of Pipe in In.	External Diameter, A	Thickness, B	Diameter of Hub, C (Approximate)	Length of Hub, D (Approximate)	Diameter of Bolt Circle	No. of Bolts	Size of Bolts
1	4	7/16	1 15/16	11/16	3	4	7/16
1¼	4½	½	2 5/16	¾	3⅜	4	7/16
1½	5	9/16	2⅝	⅞	3⅞	4	½
2	6	⅝	3⅛	1	4¾	4	⅝
2½	7	11/16	3⅝	1 1/16	5½	4	⅝
3	7½	¾	4 5/16	1⅛	6	4	⅝
3½	8½	13/16	4⅞	1 3/16	7	4	⅝
4	9	15/16	5⅜	1 3/16	7½	8	⅝
4½	9¼	15/16	5 13/16	1¼	7¾	8	¾
5	10	15/16	6 5/16	1 5/16	8½	8	¾
6	11	1	7 9/16	1 7/16	9½	8	¾

NOTE.—These dimensions conform with the A. S. M. E. and the American Standard for 125-lb. American Standard Flanges.

Threads to be American Briggs Standards taper pipe threads (A. S. M. E. Sept. 1913).

Bolt-holes should be drilled ⅛ in. larger than the bolts.

THE DISCUSSION

J. J. AULL:—In the pipe fitting trade the dimensions *C* and *D* have been left to the manufacturers and there is some variation between different manufacturers. If dimensions *C* and *D* are retained, they should be specified as approximate only.

I would suggest that a note be added that bolt-holes be drilled ⅛ in. larger than the bolt size, which is the common practice in the pipe trade.

R. A. SCHAAF:—Would you allow a ⅛-in. clearance with the bolts of small sizes?

MR. AULL:—As these flanges ordinarily come undrilled it is really an unimportant point.

TIRE AND RIM DIVISION

(21) *Solid Tire Sizes*

This subject was presented at the February meeting of the Society but was referred back to the Division pending further consideration by the National Automobile Chamber of Commerce and the Rubber Association of America. As these organizations have definitely adopted the following solid tire sizes, the Division recommends that these sizes be adopted by the Society.

The complete table with metric equivalents is as follows:

In.	Mm.	In.	Mm.
32x3	75/660	36x6	150/762
32x3½	90/660	40x6	150/864
34x3½	90/711	36x7	175/762
36x3½	90/762	40x7	175/864
32x4	100/660	36x8	200/762
34x4	100/711	36x10	250/762
36x4	100/762	40x10	250/864
34x5	125/711	40x12	300/864
36x5	125/762	40x14	350/864
40x5	125/864	.....	....

In presenting this report, C. C. Carlton said that this list of sizes proposed for S. A. E. Standard are an amplification of those sizes which were adopted previously by the Society and the War Industries Board. They were recommended by twenty members of the Tire and Rim Division and include only the present standard sizes and their metric equivalents.

(22) *Carrying Capacity of Solid Tires*

This subject has been before the Tire and Rim Division and the Truck Standards Division of the Society for some time and progress has necessarily been slow as the subject is important from the viewpoints of legislation, truck manufacture and operation and tire manufacture.

The Tire and Rim Division has approved the following recommendation in the belief that it represents good engineering practice and presents it for adoption as S. A. E. Standard:

Solid Tire Width	Up to and including 36-in. Diameter	40-in. Diameter
3	1000	....
3½	1300	....
4	1700	....
5	2500	2600
6	3300	3500
7	4200	4500
8	5200	5600
10	7000	7500
12	....	9500
14	....	11500

In presenting this recommendation, Mr. Carlton said that many of those present would remember that when a recommendation on the subject of carrying capacity of solid tires was made by the Tire and Rim Division some years ago it was voted down at a Society meeting after having been approved by the Standards Committee; that the last proposed standard is the result of 3 or 4 yr. careful experimentation by the rubber companies and that he believed it deserved the support of the Society; that every manufacturer of solid tires is now in favor of this table, and he hoped the proposal would be approved because it had been difficult to reach a compromise that everyone was satisfied with. As he understood the matter, the carrying capacities recommended in the Division report would be printed in the price-lists of all manufacturers of solid tires, and was in fact being so printed by most of them.

THE DISCUSSION

L. R. DAVIS:—These are carrying capacities that we have been using for the past 2 yr., except that we have a 3¼-in. size instead of 3½.

C. C. CARLTON:—I would like to ask a question of the rubber men present. It is my understanding that solid tires will not be guaranteed for replacement by any manufacturer if they are subjected to greater carrying loads than those given in the report. Is that correct?

MR. DAVIS:—That is correct.

RUSSELL HOOPES:—I was a member of the Division when we had the discussion years ago, and it seems to me, now that the tire companies have agreed on this, that it would be a pity not to put it through as an S. A. E. Standard.

(23) *Solid Tires for Single and Dual Wheels*

The Division recommends the following definite front and rear wheel application of the proposed solid tire sizes as supplementary to the proposed standard list of sizes:

TIRES FOR SINGLE WHEELS

32 x 3	36 x 4
32 x 3½	34 x 5
34 x 3½	36 x 5
36 x 3½	36 x 6
32 x 4	36 x 7
34 x 4	

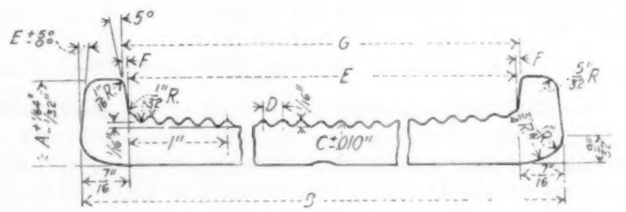
TIRES FOR DUAL WHEELS

36 x 4	36 x 8 (Single tire fits 36 x 4 dual wheel)
36 x 5	36 x 10 (Single tire fits 36 x 5 dual wheel)
40 x 5	40 x 10 (Single tire fits 40 x 5 dual wheel)
40 x 6	40 x 12 (Single tire fits 40 x 6 dual wheel)
40 x 7	40 x 14 (Single tire fits 40 x 7 dual wheel)

Mr. Carlton explained that this "application" table includes the solid tire sizes recommended for standard. They are, however, classified in this table to indicate preferable installation for front and rear wheels. Such application would, he said, work no hardship upon truck manufacturers and would greatly assist wheel makers who want standards to work to.

(24) *Base Bands for Solid Tires*

As the proposed solid tire standard includes a 3-in. size, the Division recommends that the 3-in. base band be included in the present S. A. E. Standard for Base Bands for Solid Tires.



DRAWING OF PROPOSED STANDARD BASE BAND FOR SOLID TIRES

Base Band Size	A	B	Limits of B	C	[9]Corrugations		E	G	F
					No.	D			
3	23/32	3 3/4	±1/32	5/16	16	0.181	2 23/32	3 1/16	5/64
3½	3/4	4 1/4	±1/32	11/32	18	0.191	3 7/16	3 9/16	1/16
4	25/32	4 13/16	±1/32	3/8	20	0.196	3 59/64	4 1/16	9/128
5	27/32	5 7/8	±1/32	7/16	26	0.189	4 59/64	5 1/16	9/128
6	27/32	6 7/8	±1/32	7/16	32	0.185	5 59/64	6 1/16	9/128
7	27/32	7 7/8	±1/32	7/16	36	0.192	6 59/64	7 1/16	9/128
8	7/8	8 7/8	±3/64	7/16	40	0.196	7 27/32	8	5/64
10	7/8	10 7/8	±3/64	7/16	50	0.196	9 27/32	10	5/64
12	7/8	12 7/8	±3/64	7/16	60	0.197	11 27/32	12	5/64
14	7/8	14 7/8	±3/64	7/16	70	0.197	13 27/32	14	5/64

NOTE.—The above values correspond to those adopted by the War Service Committee of the Rubber Industry of the U. S. A.

[9]Either mill corrugated or dovetail facings may be used.

Chairman Bachman stated that at the Annual Meeting in February this list was adopted and that the proposed action contemplated adding only the dimensions for the 3-in. band size which corresponds to the 3-in. tire just approved.

(25) *Solid Tire and Wheel Diameters, Wheel Circumferences*

In the past there has been some confusion owing to the inclusion of general information in this standard. In view of this the Division has revised the standard so as to include data on the standard solid tire diameters only and therefore recommends the following revised standard for adoption:

Nominal Outer Diameter of Tires		Actual Diameter Over Steel Bands		Actual Circumference Over Steel Bands[9]	
In.	Mm.	In.	Mm.	In.	Mm.
32	810	26	660.4	81 11/16	2074.7
34	860	28	711.2	87 31/32	2234.3
36	910	30	762.0	94 1/4	2393.9
40	1010	34	863.6	106 13/16	2713.1

[9]These felloe circumferences are given with the tolerances neglected. The tolerances are shown at the bottom of page 8a, S. A. E. Handbook, Vol. I.

Mr. Carlton explained that this recommendation involves merely a revision of page 8, S. A. E. Handbook, Vol. I, adding no new information and eliminating mention of sizes other than those now adopted as S. A. E. Standard.

(26) *Solid Tire Sections*

The Division recommends that the 3-in. solid tire sectional area be included in the present standard so that it will conform to the proposed solid tire standard.

Solid Tire Widths, in.	[10]Minimum Total Sectional Area of Rubber, sq. in.
3	....
3½	6.75
4	7.75
5	10.75
6	13.75
7	16.75
8	19.75
10	25.75
12	31.75
14	37.75

[10]Includes both hard and soft rubber.

Note—The above values correspond to those adopted by the Solid Tire Division, War Service Committee of the Rubber Industry of the U. S. A.

(27) *Section Dimensions of Single and Dual Solid Tire Wheels*

The Division recommends that the steel band thickness for the felloe bands for the 3½ and 4 in. tires be changed from ¼ to 5/16 in. This action is taken in view of the difficulty experienced by wood wheel manufacturers in having the bands of lighter section stretch on application to the wood wheels, thus leaving the felloe bands oversize after application. The revised standard reads as follows:

	Nominal Tire Widths		Width of Felloe and Band		Thickness of Steel Band		Felloe Thickness[11]	
	In.	Mm.	In.	Mm.	In.	Mm.	In.	Mm.
Single Wheels..	3	75	2¼	57	¼	6.35	1½	38
	3½	90	2¾	70	5/16	7.93	1½	38
	4	100	3¼	83	5/16	7.93	1⅝	41
	5	125	4¼	108	⅜	9.52	2	51
	6	150	5¼	133	⅜	9.52	2	51
	7	175	6¼	159	⅜	9.52	2	51
Giant Single to Fit Dual	8	200	8	203	⅜	9.52	2	51
	10	250	10	254	⅜	9.52	2	51
	12	300	12	305	⅜	9.52	2	51
	14	350	14	356	⅜	9.52	2	51
Dual	4	100	8	203	⅜	9.52	2	51
	5	125	10	254	⅜	9.52	2	51
	6	150	12	305	⅜	9.52	2	51
	7	175	14	356	⅜	9.52	2	51

[11]The tolerance for the felloe thickness is ± ⅛ in.

Mr. Carlton stated that this proposed change called for a steel felloe band thickness for the 3½ and 4 in. sizes of 5/16 in. This has the unanimous approval of all the wood wheel builders, their contention being that after years of experience it has been found that it is impossible to hold wheels under proper compression with the ¼-in. thick steel band, particularly in the case of the larger diameter wheels.

The table is enlarged to include all present-day information. A slight change in the list of minimum thicknesses of felloe is recommended, to place the minimum thickness of felloe for dual wheels on a 2-in. basis. The minimum thickness of felloe for the 4-in. single size has been changed to 1⅝ in. A resolution was passed at a meeting of the Automotive Wood Wheel Manufacturers Association recently, asking that this change be made in the S. A. E. Standard.

No tolerance has been recommended by the Division in connection with felloe thickness. In machining wood it is necessary to have some tolerance. This matter has been very thoroughly discussed by wood wheel makers. A 2-in. plank, say, is used green in the beginning. When it is dry and the necessary planing has been done, it is next to impossible to get a full 1⅝-in. thickness. The wood wheel manufacturers request that in addition to this table a thickness tolerance of ± ⅛ in. be adopted for all sizes.

(28) *Pneumatic Tires and Rims for Passenger Cars and Commercial Vehicles*

The Division recommends the following revised list of pneumatic tire and rim sizes for passenger cars and commercial vehicles:

Nominal Tire and Rim Sizes		Oversize Tire		Tire-Seat Dia. (Rim)		Type of Rim.
In.	Mm.	In.	Mm.	In.	Mm.	
30x3½	90/585	31x4	105/585	23	585	Clincher
32x3½	90/635	33x4	105/635	25	635	Straight Side
32x4	105/610	33x4½	120/610	24	610	Straight Side
33x4	105/635	34x4½	120/635	25	635	Straight Side
32x4½	120/585	33x5	135/585	23	585	Straight Side
34x4½	120/635	35x5	135/635	25	635	Straight Side
36x6	150/610	38x7	175/610	24	610	Straight Side
38x7	175/610	40x8	200/610	24	610	Straight Side
40x8	200/610	......	.....	24	610	Straight Side

Note.—These tire and rim sizes conform to the joint recommendation of the National Automobile Chamber of Commerce (Bulletin No. 267, Feb. 18, 1919) and the Rubber Association of America, which contemplates that they will be the only sizes used by automobile manufacturers after Jan. 1, 1920.

(29) *Wood Felloe Dimensions for Pneumatic Tire Rims*

The Division recommends that the dimensions for the sizes marked with an asterisk be included in the present standard as given in the following table:

Wood Felloe Dimensions

Nominal Tire and Rim Size	Width	Depth
30x3½	1½	1¼, + 1/16,—0
32x3½	1½	1¼, + 1/16,—0
*32x4	1¾	1¼, + 1/16,—0
33x4	1¾	1¼, + 1/16,—0
*32x4½	2⅛	1¼, + 1/16,—0
34x4½	2⅛	1¼, + 1/16,—0
36x6	3¼	1⅝ ± 1/16
38x7	3 29/32	1⅝ ± 1/16
40x8	4¼	1⅝ ± 1/16
*44x10	5¼	1⅝ ± 1/16

Dimensions in inches.

Note—The above values correspond to those adopted by the Automotive Wood Wheel Manufacturers' Association.

(30) *Carrying Capacities and Inflation Pressures of Automobile Pneumatic Tires*

The Division recommends for S. A. E. Standard the following revised and expanded table of carrying capacities for fabric and cord passenger car tires and for cord commercial vehicle tires:

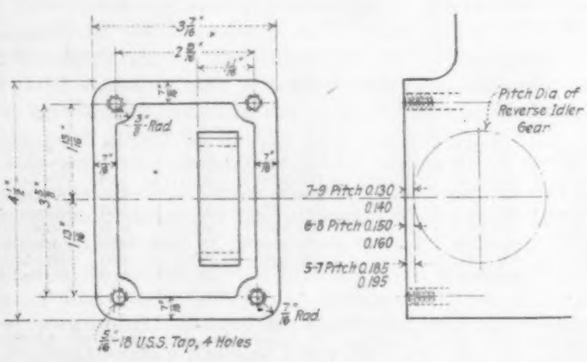
Tire Size	Fabric Tires for Passenger Cars		Cord Tires for Passenger Cars		Cord Tires for Commercial Vehicles	
	Maximum Load per Tire	Corresponding Air Pressure	Maximum Load per Tire	Corresponding Air Pressure	Maximum Load per Tire	Corresponding Air Pressure
3	375	45	400	40	......	......
3½	570	55	600	50	......	......
4	815	65	850	60	850	70
4½	1100	75	1200	70	1200	75
5	1500	85	1700	80	1700	80
6	......	......	......	......	2200	90
7	......	......	......	......	3000	100
8	......	......	......	......	4000	110
9[12]	......	......	......	......	5000	120
10[12]	......	......	......	......	6000	130

[12]The loads and pressures for these sizes are S. A. E. Recommended Practice only.

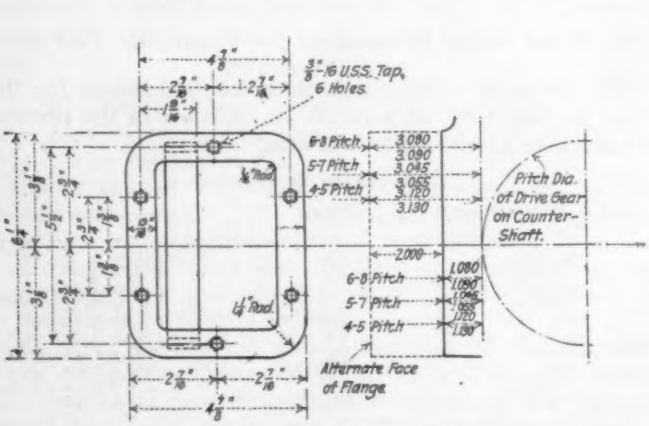
Transmission Division

(31) *Tire-Pump Mounting—Transmission*

It has been desired for some time to have a standard tire-pump transmission mounting and, with the development of truck pneumatic tire equipment, this subject has been taken up by the Transmission Division in joint meetings with transmission and truck manufacturers. It is believed that the two sizes proposed cover all general requirements and provide adequate means for mounting the tire-pump on the transmission without causing radical changes in transmission design. The Division therefore recommends for adoption as S. A. E. Standard the large and small types of transmission mountings shown in the following drawings:



Small Type Mounting



(Conforms to A. W. Copland's Drawing No. L-1143)

Large Type Mounting

This subject has also been considered by the Truck Standards Division for power take-off.

[The 1¼-in. outer radius for the larger size of mounting was inadvertantly omitted from the illustration in the report printed for the Standards Committee meeting]

A. W. Copland in presenting this report stated that practically all tire-pump manufacturers had agreed to the recommendations made therein.

Tractor Division

(32) *Rims, Cleats and Lugs for Tractor Wheels*

This subject has been considered by the Division in order to standardize as far as thought desirable the number of sizes and thicknesses of tractor wheels and the punching of rims. Definite standards are considered desirable on account of adverse legislation and the large variations in designs and dimensions which are not considered necessary in good engineering practice. It has not been considered feasible to carry the standard beyond the points proposed at the present time, but it provides definite data on which tractor manufacturers can base their practice.

The work has been in the hands of the Sub-Division and is based on data secured from representatives of the industry, carefully analyzed in accordance with present practice giving the best results.

Tractor Front Wheels

PLAIN FLAT PLATE RIMS

Wheel Diameter, in.	Width of Face, in.	Thickness of Rim, in.
28	5 or 6	3/8
32	5 or 6	3/8
36	5 or 6	3/8
42	5 or 6	3/8
46	4, 5 or 6	3/8

FLANGED TYPE RIMS

28	5	3/16
32	5	3/16
36	5	3/16
42	5	3/16
46	4 or 5	3/16

Note: Stock from which flanged tires are made to be 1 in. wider than the face of the finished tire.

Tractor Rear Wheels

42	8 or 10
48	10 or 12
54	10 or 12
60	10 or 12

Diameter of holes for lugs and cleats......11/16 in.
Diameter of bolts for locking cleats..........3/8 in.

Truck Standards Division

(33) Power Take-Off

The preceding recommendation on Transmission Tire-Pump Mounting was referred by the Transmission Division to the Truck Standards Division as being well adapted for use in mounting the power take-off on trucks. The Truck Standards Division carefully considered this proposal with reference to the design of the power transmitting mechanism and the power required to be transmitted. It was agreed that the application is entirely suited to power take-off except in possibly some few special instances, which would not naturally come within the range of a standard. The Division therefore recommends for adoption as S. A. E. Recommended Practice for Power Take-Off the recommendation of the Transmission Division on Tire-Pump Mounting.

UNACCEPTED RECOMMENDATIONS

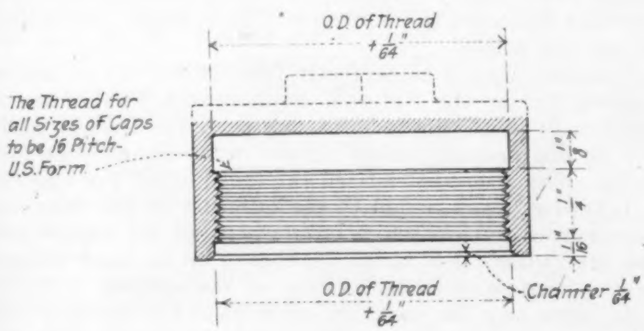
In addition to the foregoing Division recommendations which were approved, a number of others were either referred back to Division for further consideration or definitely rejected. These are given below with the discussion at the Standards Committee meeting.

Miscellaneous Division

Tank and Radiator Caps

Some time ago the members of the Miscellaneous Division proposed this standardization to eliminate the many varieties of cap threads, pitches and diameters. Data obtained from fifty-six companies representing both makers and users, showed that they were using sixty different types and sizes of fuel tank caps and fifty-eight different types and sizes of radiator caps.

These data have been carefully analyzed by the Division, and the following fifteen diameters, all having the common pitch of 16 U. S. Form, were proposed for standard. This pitch corresponds with the present S. A. E. Standard fine pitches in all except the first five cases.



Outside Thread Diameters

1	2
1⅛	2¼
1¼	2½
1⅜	2¾
1½	3
1⅝	3½
1¾	4
1⅞	

All dimensions in inches.

In presenting the report E. H. Ehrman, chairman of the Division, stated that only one firm adhered to pipe thread standards for tank caps. With reference to the companies represented, the tractor, truck and passenger car interests were included, as well as radiator and tank manufacturers and engine builders.

[This subject was referred back to the Miscellaneous Division]

THE DISCUSSION

J. J. AULL:—I think the ⅛-in. sizes can be eliminated, as there are a good many sizes. It is not clear whether the diameter given is for the male thread. I believe that insufficient guide will be provided by the 1/16-in. counterbore.

R. J. DUBARRE:—I do not understand whether this standard is recommended for castings or stamped fittings.

E. H. EHRMAN:—We are using 18 threads per in. for spark-plug thread, which is finer than the thread recommended.

MR. DUBARRE:—The commercial iron casting will not give a very good thread of the pitch specified.

W. T. NORTON, JR.:—In general axle practice 16 threads per in. is used on malleable castings.

MR. EHRMAN:—Answering Mr. Aull's question, I would say that the Division did not wish to specify dimensions other than the nominal ones, as it has in view making a report in the near future dealing with tolerances and limits for different classes of thread in general.

M. W. HANKS:—It is my understanding that the Miscellaneous Division, when it formerly recommended a series of S. A. E. fine threads, wanted to have those applied to various parts. In this case they deviate from it. What is the value of having a formal standard if, when something comes along, it is not followed? I would like to know also why it is necessary to have ⅛-in. sizes below 2 in.

MR. EHRMAN:—There seemed to be so many of all the ⅛-in. sizes listed in use that the Division did not have the courage to eliminate any of them. We regard our report as being a refinement in eliminating 1/16-in. sizes and thought we had gone far enough.

With reference to the question of adhering to the S. A. E. Standard fine pitch series, we have the same condition to contend with that we had in the report of the Lighting Division on lens diameters, and this is that if you prescribe a standard in conflict with general practice, you are simply adding to confusion. As I remember it, the S. A. E. fine series was proposed to aid in the selection of pitches for certain sizes where tubing was threaded and especially fine adjustments were required. That table in itself is not complete. There should be more discretion allowed. It is not feasible to make use of 20 or 24 threads in a filler pipe cap in general.

Answering one of Mr. Aull's questions, I would say that there is no objection to ⅛-in. counterbore except on the score of wasting the metal, which is brass in a great many cases. As far as the length of the thread is concerned, we were guided by the data we received, the average entire length being ½ in., of which approximately ¼ or 5/16 in. was used, the remainder being clearance above or below the thread. The Division believes that ¼ in. is the proper length of thread, but is open to suggestion so far as the 1/16-in. petticoat is concerned.

MR. HANKS:—The standard S. A. E. fine pitch for a

1-in. thread is 20; from there on, including $1\frac{1}{2}$ in., it is 18; and from there on it is 16. I cannot make too strong a plea that we try to conform to existing S. A. E. Standards. When we adopt a standard, let us make it right, so that we can adhere to it and not deviate. These screw thread standards are put before us as a basis in future design and I believe we should adhere to them.

E. E. SWEET:—It is my opinion that the cap will pick up the thread as quickly with a 1/16-in. counterbore, as it will with ⅛ in. Regarding the second thought that has been brought out by Mr. Hanks as to the Division recommending 16 pitch from the 1 in. up, I would say that 20 or 18 pitch is rather fine to catch the thread.

R. A. SCHAAF:—One thing we ought to consider in discussing the pitch is the length of time of screwing the caps on.

TRACTOR DIVISION

Nominal Tractor Engine Rating

Present methods of rating tractors by operating tests have proved very unsatisfactory and unfair, because operation, engine and soil conditions cannot be duplicated with any degree of accuracy. Legislation in regard to tractor rating is very important and a satisfactory means of uniform rating will assist in legislation and put all tractors on a fair basis for commercial comparison.

The Division has prepared its recommendation after careful consideration, both by circularizing the industry and in conference with tractor engine builders and users. The proposal is offered as Recommended Practice rather than Standard because it is believed that the proposed rating is not the final word. The formula provides the best that can be worked out at this time as a definite basis on which to rate tractors.

The formula is satisfactory for tractors and stationary engines burning either kerosene or gasoline. Various mechanical arrangements would influence actual results, but the proposed method is entirely logical and consistent. The results obtained using this formula are almost exactly 80 per cent of the brake horsepower under average good conditions, which provides the desired 20 to 25 per cent reserve power. It is not intended that the empirical formula should be used for engineering calculations, and this will be so explained in the publication of the Standard if adopted.

The nominal tractor engine rating is based on a piston displacement of 13,000 cu. in. per min. per hp., as expressed by the following formula, as this is considered the best average factor after carefully considering stationary and tractor engine practice. The rating recommended by the Division is:

$$\text{Nominal rated horsepower} = \frac{0.7854D^2LRN}{13{,}000} \quad \text{where}$$

D = piston diameter in inches
L = stroke in inches
R = r.p.m. of crankshaft
N = number of cylinders

The adoption of this method of rating would make null and void the present Belt Power Rating printed on page 55, S. A. E. Handbook, Vol. I.

[This was not adopted as it was felt that it was more of a commercial than an engineering question and as such was outside the scope of the Society's standardization work. It was, however, unanimously voted to recommend this rating to the industry as a fair commercial practice upon which it can base a standard industrial rating for tractors, but not as an S. A. E. Standard]

This report was presented by Dent Parrett, chairman of the Division, and was concurred in by L. S. Keilholtz, chairman of the Stationary Engine and Lighting Plant Division, which had also considered the subject.

THE DISCUSSION

H. L. HORNING:—As you know, tractors are rated variously. We have a 230, a 337 and a 430 cu. in. engine, all of which are rated the same by various companies which build tractors and use our engine. You can imagine the confusion this makes for us and the amount of argument we have to put up to demonstrate to users why the fellow with the 230-cu. in. engine thinks he has as much power as the one with 430. This sort of thing has gone on for years, and the result is that there is such confusion at the present time that legislatures throughout the country are taking the subject up, because farmers have continually bought tractors only to find that their ratings are fictitious and based on the desire of the builder and his agents to sell a large product.

Suddenly last winter the industry was faced with the fact that the State of Nebraska had passed a law by which it became necessary for tractor builders to take their models to Nebraska to be tested. Tractors found to perform up to the rating specified in the makers' catalog were permitted to be placed on sale in that State; otherwise they had to be retested or their rating modified. In North Dakota a tractor must make good, according to its rating, or its builder must take it back. It was this condition that spurred the Division to the conclusion to set up a formula which legislatures throughout the United States could use as a basis in framing laws that would be reasonable.

There is no one in the industry who will not be benefited if we can do this. In going over it, I cannot help but feel that it is a good thing; it helps to meet the situation. But I take issue with the idea that the Society should adopt the formula recommended. The whole basis of my argument is that we are an engineering society. Out of the recommendations that we make must come a very high engineering standard that the industry and the consumer must follow. All through business we search for truth. I believe in this instance that if we followed the recommendation of the Tractor Division we would be dodging the issue; we would not be telling the truth about a given tractor, but merely saying that this formula indicates the horsepower to be hoped for with a given size engine.

I believe that it is perfectly feasible for the industry, represented by the National Implement & Vehicle Association, to adopt this formula, but that it is not advisable for an engineering society to put out a commercial formula. The size does not tell the truth about the engine.

Likewise, when we go to the question of the drawbar horsepower, the loss which occurs between the engine and the rear wheels is a factor depending on so many things that a treatise could be written on the subject.

In some way the industry must meet the problem before us. We could say to the tractor industry that the Society of Automotive Engineers recommends that the proper body adopt a commercial formula approximately like that recommended in the report of the Tractor Division. But I think that the placing of the formula upon our records of standards and recommended practices would lead to endless confusion among the laity and unscrupulous salesmen.

I make this statement that you may see the situation as I do, hoping that out of your judgment will come a solution which will secure the approval of the industry and meet the situation better.

A. M. DUDLEY:—I have had more to do with standardization in the American Institute of Electrical Engineers than in the Society of Automotive Engineers. I agree fully with the basic idea just advanced. A horsepower is a horsepower, one definite fixed thing. If the engine could be put on the block in every case and its horsepower curve drawn, it would be possible to tell what horsepower the engine developed. It is not possible to test all these engines under such conditions. Hence, commercially, there must be some way of comparing the various engines, and I think that the Tractor Division avoided the danger of specifying that there are pink, blue and green horsepowers when it used the expression "nominal rated horsepower." We do not say definitely that that is the horsepower but that this is a nominal rating formula for purposes of comparison. It seems to me that it accomplishes what it is necessary to do in the industry without, as Mr. Horning says, giving people the idea that there are different kinds of horsepower. I think that the expression "nominal rated horsepower" takes off the curse of the S. A. E. endorsing anything but actual dynamometer horsepower.

DENT PARRETT:—The method of rating adopted by the S. A. E. some 2 yr. ago was on the basis of a 2-hr. test on the belt and a reduction of 20 per cent, and a basis of a 2-hr. test at the drawbar and a reduction of 20 per cent. In other words, the nominal rating would be 80 per cent of what the tractor would do for 2 hr. continuously on the belt or drawbar. Not more than one or possibly two tractors are rated according to this S. A. E. Standard. The difficulty of making tests on the belt is brought about by the fact that generally the belted dynamometer is in a room and with change of temperature there is a difference in the horsepower output. It is very easy to get a result which at 80 per cent may be lower or higher than in average production. When it comes to making drawbar tests it is even harder, because of the variation in ground conditions and the difficulty of placing upon a tractor a constant load which will give a fair rating. I am somewhat familiar with the trouble they are having in Nebraska to formulate plans for making these tests. I understand they called a meeting of manufacturers' representatives recently to go over the proposition. They are working on various plans to establish a method of getting uniform ground conditions. They are even trying to work out a cinder track, this to be sprinkled before each tractor starts its test; also to build a dynamometer trailer with electrical resistance that will be automatically controlled to give a constant load. The present ratings of tractors are simply nominal trade ratings. While we recognize, as stated in our report, that this recommended formula is not ideal or the final answer, we feel that it would improve the present chaotic condition. The formula presented is a basis for comparison. In other words, I think it does not make much difference whether we use 13,000 to 14,000 cu. in. per min. displacement as a factor. The Tractor Division has considered the whole matter at two meetings and spent 3 or 4 hr. in discussion at each meeting. From a study of the data of various tests, it seems that the 13,000-cu. in. figure is logical.

Whether the Society should approve the formula is for the Standards Committee to decide. It is very important that we do something, if it is within the province of the Society, to help clear up the situation. Otherwise, the manufacturers' association or somebody will have to take the question up and try to solve it. I felt that we could do something in this connection. We are organized and can handle a subject like this better than the manufacturers can at an ordinary meeting, where they are usually represented by men who are not familiar with engineering problems. It is very difficult to get a meeting such as that to consider any basis of this kind, and in support of that I would like to give some information from the manufacturers' Tractor Demonstration Committee (of which I am a member), which held a meeting during the Kansas City tractor show. At that time we knew of the laws referred to, and the suggestion was again made that we invite the United States Department of Agriculture to make tests of tractors to establish Government ratings. This question came up some 3 yr. ago and one of the divisions of the Department called a meeting in Washington which I attended along with some of the other manufacturers. The difficulty then was that they could not secure an appropriation. That condition still exists unless the appropriation has been passed very recently. Even if Congress does make an appropriation and authorize some division of the Agricultural Department to conduct the tests, it will encounter the same difficulties that are now being experienced at the University of Nebraska. I question whether the Department would accomplish as much as the University has accomplished, because there are connected with the latter a number of men who have had experience in testing tractors.

CHAIRMAN BACHMAN:—You have facing you for decision the matter which has been discussed in a way that I believe covers the whole situation very clearly. I will say that in conjunction with Mr. Parrett, Mr. Horning and Mr. Clarkson, I have very carefully gone over a considerable amount of correspondence which has arisen out of this proposition. I believe it can be summed up this way. We have an industry that is facing a problem. It may be difficult for the commercial side of that industry to relieve itself, unless technical information and assistance are given to it. If I am not mistaken, the Tractor Division of the Standards Committee represents a large proportion of the technical work of the tractor industry. It has attempted to develop something which would relieve the condition described, and what has been proposed here is its suggestion for a solution. The Society has never endorsed an ability formula for any apparatus which is represented in our ranks. In the automobile field the dimensional formula, which was first adopted in this country by the old Association of Licensed Automobile Manufacturers and continued by its successor, the National Automobile Chamber of Commerce, has never been adopted by the Society as an engineering standard. It has been approved under certain conditions as a basis for taxation. I think you are all familiar with that proposition. The same question arises here. As I understand it, Mr. Horning is raising no question as to the commercial merit of this formula. He is simply raising a question as to the advisability of the Society as an engineering organization placing its name back of the formula. Mr. Parrett has attempted on the other hand to give you a picture of the existing conditions which have made action necessary.

F. E. CARDULLO:—I would like to ask if it is the belief of the Tractor Division that the adoption of such a formula would satisfy the various State legislatures. It is, of course, obvious that an engine may be in poor condition and fail to deliver the horsepower expected. Now, are the legislatures interested specially in the size of the engine and its ability to deliver horsepower under given conditions or in the ability of the engine which

the farmer purchases to deliver a specified horsepower under the conditions in which he finds it when it is delivered to him?

CHAIRMAN BACHMAN:—As I understand the statements that have been made, what the legislatures are interested in is knowing that the statement which the builder has made as to what his engine will do is a statement which can be borne out by facts. Is that right?

MR. PARRETT:—That is right. I might add further that the North Dakota law gives the farmer the right, within a reasonable length of time, to ask that his tractor be tested to prove whether it is delivering its rated horsepower. The point I did not make clear possibly was that this formula would give most tractors, the tractors as you speak of them in averages, a more conservative rating than the present trade ratings. With a standard method of arriving at a nominal horsepower, it would then be up to the builder and through his representative, the branch house or the distributor, down to his dealer, to see that the tractors work in the field properly in comparison with tractors of similar rating. This would provide a standard starting point in what we might expect the tractor to do; not that it would be an ideal, but simply be a step in the right direction and a considerable improvement over our present condition, with simply nominal trade ratings.

I have good reason to believe that if this proposed rating had been in force at the time the legislation was in question, the present law would not have been passed. The Nebraska legislature passed a bill which instructed the University to proceed to test the tractors. No appropriation was made to defray the expenses.

Nominal Tractor Drawbar Rating

Practically all tests and demonstrations show an average drawbar rating of 50 per cent of the tractor engine rating. These results cover various operating conditions and this percentage gives a very fair rating. The Division therefore recommends for adoption the following:

The tractor drawbar rating shall be 50 per cent of the tractor engine (belt) horsepower rating.

If desired, this may be expressed

$$\text{Drawbar rating} = \frac{0.7854\ D^2LRN}{26{,}000} \quad \text{where}$$

D = piston diameter in inches
L = stroke in inches
R = r.p.m. of crankshaft
N = number of cylinders

$$\text{Drawbar pull, lb.} = \frac{\text{Rated drawbar horsepower} \times 375}{\text{miles per hour}}$$

The adoption of the above method of rating would make null and void the present Drawbar Rating Standard printed on page 55, S. A. E. Handbook, Vol. I.

[This recommendation on this subject was not approved by the Standards Committee for the same reason that that on nominal tractor engine rating was not approved]

ATTENDANCE AT MEETING

Standards Committee Members

Aull, Jerome J.
Bachman, B. B.
Bradley, C. I.
Broege, R. J.
Burnett, R. S.
Cardullo, F. E.
Carlton, C. C.
Cautley, John R.
Chauveau, Roger
Clarkson, C. F.
Copland, Alex. W.
Davis, L. R.
De Waters, E. A.
Dudley, A. M.
Dunham, George W.
Ehrman, E. H.
Fuller, L. C.
Goldsmith, F. C.
Greene, H. L.
Hale, J. E.
Hanks, M. W.
Harley, W. S.
Heldt, P. M.
Hendrickson, R. O.
Hinkley, C. C.
Horning, H. L.
Kalb, L. P.
Keilholtz, L. S.
Keyes, W. C.
Manly, Charles M.
Nelson, J. H.
Norton, W. T., Jr.
Parrett, Dent
Rice, H. E.
Richards, A. W.
Schaaf, R. A.
Stagg, H. J., Jr.
Sweet, E. E.
Tubbs, George E.
Vincent, J. G.
Wemp, E. E.
White, S. O.
Whittington, F. G.

Society Members and Guests

Apple, V. G.
Begg, R. S.
Briggs, George T.
Brown, F. I.
Carhart, George C.
Caywood, Thomas G.
Chatto, B. H.
Clay, H. E.
Conant, W. H.
Costello, J. V.
Dickinson, H. C.
DuBarre, R. J.
Ferguson, J. C.
Fischer, E. J.
Frankel, Mortimer
Frehse, A. W.
Gardner, G. M.
Gray, I.
Hatch, Darwin S.
Healy, L. J. D.
Holdsworth, P. M.
Hoopes, Russell
Hutchins, W. H.
Johnston, J. H.
Kranich, F. N. G.
Kroeger, E. C.
Lack, F. S.
Lovenstein, S. V.
Lum, P. B.
McGrath, William L.
Mitchell, R. B.
Modine, A. B.
Moody, C. L.
Mudge, R. B.
Noble, I. M.
Palm, G. H.
Ramey, Frank W.
Redhead, J. H.
Reid, William
Rittenhouse, Paul L.
Sanford, G. A.
Saspar, Charles
Schipper, J. Edward
Scoville, A. D.
Slack, F. W.
Smith, M. A.
Spong, N. C.
Thomson, Procter
Trempe, A. D.
Tubbs, F. Q.
Weinberg, Fred
Whitbeck, J. V.
White, B. F.

THE 200-HP. MERCEDES ENGINE

THE 200-hp. high-compression Mercedes engine is the first of this make to be fitted with an altitude compensator carbureter. This compensator is arranged so that it is impossible to run the engine all out on the ground.

In most respects this engine is identical in design with the standard 180-hp. Mercedes engine, except as to the following points:

(1) New design of pistons, giving increased compression
(2) Carbureter fitted with altitude control
(3) Induction water-jacketed manifolds
(4) Duplex horizontally opposed air-pumps
(5) Wireless dynamo mounted on induction side of crankcase, driven by gearing from rear end of crankshaft

The pistons used in these engines are of the usual Mercedes construction, being built up with steel crowns which carry the piston-pins. The crowns are screwed and welded into their cast-iron skirts, and are considerably domed as compared with the concave heads used in the standard 180-hp. Mercedes engines, thus giving a compression ratio of 5.73 to 1, an increase of 23.54 per cent.

Standard 180-hp. Mercedes connecting-rods are fitted, and the distance from the piston-pin center to the top of piston is the same as before.

The carbureter fitted to this engine is of the standard Mercedes type, with the exception of the throttle barrel, which is slightly modified to provide the automatic altitude control. This device consists of two extensions on the bottom of the barrel diametrically opposite to each other.

Slots are cut in the sliding air-valve to correspond with the extensions on the throttle barrel. The throttle control lever is marked for opening out to its maximum ground level position, and at all throttle openings up to this mark the lift of the sliding air-valve is restricted, owing to its coming in contact with the extensions on the throttle barrel. Immediately the throttle is opened past the mark on the control lever, the extensions on the throttle barrel come in line with the slots in the sliding air-valve, allowing the air-valve to lift to its maximum position and uncover extra air holes, thus weakening the mixture to such an extent that the engine stops if the throttle is fully opened on the ground.

The induction manifolds are fitted with welded steel water-jackets in place of the usual asbestos lagging. The jackets are each in direct communication with a feed from the water-pump to the carbureter, the respective outlets being connected to the rear end cylinder jacket. Circulation is controlled by a cock on the return pipe, presumably for use in hot weather, which does not affect the water supply to the carbureter jackets.

A double-acting air-pump of the usual plunger type is now fitted in place of the standard Mercedes air-pump used hitherto on these engines. Both plungers are operated by a small common crank attached to the front end of the camshaft.

Tests

Three sets of calibration curves were taken in the following order:

(1) With the carbureter opened out to its maximum position for ground level running
(2) With the sliding air-valves fixed at the base of the choke tubes and the throttle fully opened
(3) With a 180-hp. Mercedes carbureter, which had no altitude control fitted in place of the standard carbureter, the jets being opened out to suit the engine and the curves being taken with the throttle fully opened

In the last test a small amount of trouble was experienced with overheating, due to the high-compression ratio employed, but this was overcome at the expense of gasoline consumption.

From the general running it is assumed that the normal speed of the engine is between 1500 and 1600 r.p.m., as these are the best running speeds. Below 1400 r.p.m. the engine is very rough, and it has a very bad period between 1000 and 1200 r.p.m.

SUMMARY OF POWER CURVES

Speed, r.p.m.	1200			1400			1600		
Test conditions	1	2	3	1	2	3	1	2	3
Power developed, b.hp.	148.5	144.5	151.0	164.0	174.0	180.0	171.0	186.0	204.0
Brake mean effective pressure, lb. per sq. in.	108.5	105.5	110.0	102.5	109.0	112.5	94.0	102.0	111.9
Fuel consumption per b.hp. per hr., pt.	0.515	0.650	0.680	0.511	0.590	0.645	0.520	0.590	0.629

Maximum power recorded—217 b.hp. at 1750 r.p.m

Induction pipe depressions were taken between Nos. 1 and 2 cylinders

Subsequently two 1-hr. duration tests were run at 1500 and 1600 r.p.m. respectively, and the results are given below:

Speed, r.p.m.	1,500	1,600
Average power, b. hp.	168	171
Average water-inlet temperature, deg. cent.	60	58
Average water-outlet temperature, deg. cent.	67	63
Average oil pressure, lb. per sq. in.	20	20
Average temperature in oil tank, deg. cent.	23	20
Oil consumption per b. hp. per hr., pt.	0.024	0.029
Gasoline consumption per b. hp. per hr., pt.	0.540	0.565

Comparative Data

In view of the similarity of design of the 160, 180 and 200 hp. high-compression Mercedes engines, the brief comparison of the principal features as given in the accompanying table is interesting:

Size of engine, hp.	160	180	200
Bore, mm.	140	140	140
Stroke, mm.	160	160	160
Compression ratio	4.5: 1	4.64: 1	5.73: 1
Normal b. hp.	162.5	174.0	204.0
Normal speed, r.p.m.	1,400	1,400	1,600
Brake horsepower per cu. ft. of cylinder volume	312.0	334.0	391.0
Brake horsepower per sq. in. of piston area	163.5	175.0	205.4
Normal brake mean effective pressure, lb. per sq. in.	102.0	109.0	112.0
Fuel consumption per b. hp. per hr., pt.	0.580	0.545	0.629
Diameter of choke tubes, mm.	0.240	0.240	0.240
Capacity of main jets, cc. per min.	355	355	250[1]
Oil consumption per b. hp. per hr., pt.	0.031	0.042	0.029

[1]Figure given is for standard jet; in making test a jet having a capacity of 450 cc. per min. was used.

Valve-Timing

Inlet opens	2 deg. L.	Top dead center	1 deg. L.
Inlet closes	35 deg. L.	40 deg. L.	40 deg. L.
Exhaust opens	63 deg. E.	40 deg. L.	46 deg. E.
Exhaust closes	13 deg. L.	10 deg. L.	8 deg. L.

Tappet Clearances

Inlet		0.017 in.	0.017 in.
Exhaust		0.014 in.	0.015 in.
Magneto timing	30 deg. E.	30 deg. E.	30 deg. E.

—*Aeronautical Engineering* (London).

PERSONAL NOTES OF THE MEMBERS

Benjamin H. Anibal, assistant chief engineer of the Cadillac Motor Car Co., Detroit, Mich., has been appointed chief engineer of the company.

F. C. Barton has resigned as application engineer with the Bijur Motor Appliance Co., Hoboken, N. J., to accept a position in the lighting department of the General Electric Co., Schenectady, N. Y.

H. R. Brate, formerly secretary of the National Gas Engine Association, has accepted a position in the editorial department of the Chilton, Co., Philadelphia, Pa.

A. B. Browne, who has been serving with the motors and vehicle division, Quartermaster Corps, has been discharged from the Army with the rank of major. He has accepted a position as chief engineer and director of sales with the A. J. Detlaff Co., Detroit, Mich.

W. B. Burgess has resigned as factory superintendent of the Midland Motor Car & Truck Co., Oklahoma City, Okla., to accept a similar position with the Texas Motor Car Association, Fort Worth, Tex.

Robert L. Carr has accepted a position as salesman in the St. Louis branch of the truck tire sales department, Goodyear Tire & Rubber Co. He was formerly truck sales engineer with the Dorris Motor Car Co., St. Louis, Mo.

J. N. Critchlow has resigned as inspection engineer of the United Alloy Steel Corporation, Canton, Ohio, to accept a similar position with the Bethlehem Steel Corporation, South Bethlehem, Pa.

J. B. Davidson has been appointed professor of agricultural engineering at the Iowa State College, Ames, Iowa. He formerly occupied the same chair at the University of California.

A. Y. Dodge has resigned as engineer in charge of designing and equipment, Bureau of Standards, to accept a position with the Wallis Tractor Co., Racine, Wis., where he is assisting the tool and tractor engineer.

Benjamin M. Engesser has been discharged from the Army with the rank or second-lieutenant and has accepted a position with the Goodyear Tire & Rubber Co., Akron, Ohio.

J. D. Hammond has resigned as chief engineer of the Peninsula Portland Cement Co., Cement City, Mich., and is now superintendent of maintenance with the Hayes Wheel Co., Jackson, Mich.

H. O. C. Isenberg has accepted the position of general manager of factories with the Remington Typewriter Co., with headquarters at Ilion, N. Y. He was formerly factory manager for the Wright-Martin Aircraft Corporation, New Brunswick, N. J.

Rufus B. Jones has resigned as chief engineer of the Continental Car Co., Louisville, Ky., and accepted a position with the Standard Parts Co., Cleveland, Ohio.

William G. LeFevre, who has been serving in France with the Ordnance Department and the Motor Transport Corps, has been discharged from the service and is now special representative of the Kelly-Springfield Motor Truck Co., with headquarters at Denver. Col.

Joseph Leopold has resigned as sales manager for the Jones-Motrola, Inc., New York City, to accept the position of sales manager with the Trego Motors Corporation, New Haven, Conn.

Alexander Matheson, assistant to the vice-president of the American Bosch Magneto Corporation, has been transferred from the main office at Springfield, Mass., to the New York City branch office.

Lewis H. Morrill has resigned as assistant engineer with the Buda Co., Harvey, Ill., to accept a position as engineer of truck and tractor engines with the Mid-West Engine Co., Indianapolis, Ind.

Charles B. Page and Milton Beck have organized the Page Company, Inc. The new organization will have its offices in the Edison Building, Chicago, Ill., and will specialize in automotive and industrial engineering. Mr. Page was formerly engaged in consulting automotive engineering work and Mr. Beck was research engineer with the Duesenberg Motors Corporation, Elizabeth, N. J.

G. H. Peterson has left the employ of George White, Jersey City, N. J., and recently sailed for Sweden.

P. J. Piccirilli has been discharged from Government service. He has made no plans for the future.

E. J. Ross, Jr., has resigned as manager of the sales engineering department, Edison Storage Battery Co., to accept a position with the Locomobile Co. of America in its Washington office.

Charles Frederick Smith has severed his connections with James Cunningham, Son & Co., Rochester, N. Y., to accept a position in the engineering department of the Chandler Motor Car Co., Cleveland, Ohio.

Charles C. Walsh has resigned as sales engineer for the Michigan territory of the S. K. F. Industries, Inc., and will act as representative for F. R. Blair & Co., Inc., for the states of Michigan and Indiana, with headquarters at 571 Dickerson Avenue, Detroit, Mich.

BRITISH ASSISTANCE TO AMERICA IN TRAINING AVIATORS

THE Government of the United States has paid a striking tribute to the British Air Service by adopting its system of training. The first 500 American officer cadets to be trained went through the School of Military Aeronautics at Oxford, being subsequently graduated at various airdromes in England. These officers formed the nucleus of American schools which were eventually started both in the United States and in France. In addition to this training of American pilots, ten American squadrons were partially trained in Canada under a reciprocal agreement whereby Canada obtained the use of certain American airdromes at seasons when weather conditions rendered some of the Canadian airdromes temporarily unavailable. Four of these squadrons completed their training in England and were then attached to the Royal Air Force in the field to gain experience under service conditions for 6 to 8 months. The remaining six went directly to the American authorities in France. In all, about 700 American pilots have passed through English schools and been graduated at English airdromes where they received their final training before going into active service.

An agreement was also entered into under which a pool of American mechanics up to a maximum of 15,000 at a time was maintained in England. The arrangement was mutully advantageous, as, while relieving the demand for skilled tradesmen in the Royal Air Force, it also assisted the Americans to train their own squadrons for service in the field. This personnel, coming from America untrained, was attached to training units for 3 to 8 months, being then sent to France from time to time in the form of complete squadrons until a total of fifty squadrons was reached, in accordance with the demands of the American command in France.

Seventy-seven complete machines and 100 Le Rhône engines have been supplied.—From British Effort During the War (Parliament paper).

Applicants *for* Membership

The applications for membership received between June 28 and July 17, 1919, are given below. The members of the Society are urged to send any pertinent information with regard to those listed which the Council should have for consideration prior to their election. It is requested that such communications from members be sent promptly.

BRUNTON, S. L., manager, Hadley Castle Works, *Wellington, Shropshire, England.*

BUTLER, GILBERT, treasurer and assistant general manager, Bossert Corporation, *Utica, N. Y.*

CALL, C. A., manager Eastern sales division, Gurney Ball Bearing Co., *Jamestown, N. Y.*

CARPENTER, W. H., general manager, Dean Forging Co., *Muncie, Ind.*

CHEEL, HAROLD W., instructor, Sheffield Scientific School, Yale University, *New Haven, Conn.*

EAMES, HERBERT S., engineer, Northway Motors Corporation, *Natick, Mass.*

FERNSTRUM, F. O., draftsman, Gray Motor Co., *Detroit, Mich.*

FISHER, LAWRENCE W., draftsman, Continental Motors Corporation, *Detroit, Mich.*

GASTON, RALPH M., chief engineer, George P. Nichols & Brother, *Chicago, Ill.*

GUY, SIDNEY SLATER, managing director, Guy Motors Ltd., Fallings Park, *Wolverhampton, England.*

KESSLER, A. G., vice-president, General Ordnance Co., *New York City.*

KINNEY, J. S., engineer, Westinghouse Electric & Mfg. Co., *East Pittsburgh, Pa.*

KLEIN, S. C., Western representative, Fedders Mfg. Co., *Buffalo, N. Y.*

MCWILLIAMS, JOHN BRUCE, general manager, Hero Mfg. Co., *Philadelphia, Pa.*

MANN, ROBERT B., engineer in experimental engineering department, International Harvester Corporation, *Chicago, Ill.*

MITCHELL, R. B., engineer, Alamo Farm Light Co., *Hillsdale, Mich.*

NORMAN, CARL A., professor of machine design, Ohio State University, *Columbus, Ohio.*

PENNINGTON, CAPT. G. R., Ordnance Department, Van Dorn Iron Works Co., *Cleveland, Ohio.*

POTTER, MILVILLE R., service manager, Genesee Motor Car Co., *Syracuse, N. Y.*

SAWENS, CHARLES M., chief draftsman, James Cunningham, Son & Co., *Rochester, N. Y.*

SCHEIBNER, LAWRENCE F., designing engineer, Hero Mfg. Co., *Philadelphia, Pa.*

SCHULZ, WALTER F., consulting engineer, Savage Arms Corporation, *New York City.*

SCHWATT, ERWIN L., aviation engine mechanician, Bureau of Standards, *Washington.*

SERRE, CHARLES, chief engineer, Usines Renault, 15 Rue Gustav Sandoz, *Billancourt, Se., France.*

SLATER, EMMETT J., chief engineer, Clay Engine Mfg. Co., *Cleveland, Ohio.*

THOMSON, PROCTER, chemical engineer, Sears, Roebuck & Co., *Chicago, Ill.*

THOMPSON, RUSSELL G., electrical engineer, automotive equipment, Westinghouse Electric & Mfg. Co., *East Pittsburgh, Pa.*

TURNER, CHARLES H., chief engineer and assistant to the assistant to the president, Osgood Bradley Car Co., *Worcester, Mass.*

UNWIN, HARRY, vice-president and general manager, Reo Motor Car Co. of Chicago, Inc., *Chicago, Ill.*

VAN COURT, ELIAS J., owner, Garage & Welding Works, *Twin Falls, Idaho.*

VAN KEUREN, H. L., associate manager of manufacture, Wilton Tool & Mfg. Co., *Boston, Mass.*

VINCENT, JOSEPH E., JR., general manager, Iron, Steel, Metal & Alloy Co. of America, *New York City.*

WAGONER, VICTOR J., mechanical draftsman, Moreland Motor Truck Co., *Los Angeles, Cal.*

Applicants *Qualified*

The following applicants have qualified for admission to the Society between June 16 and July 15, 1919. The various grades of membership are indicated by (M) Member; (A) Associate Member; (J) Junior; (Aff.) Affiliate; (S. E.) Student Enrollment; (S. M.) Service Member; (F. M.) Foreign Member.

ALLEN, THEODORE T. (A) western manager, merchandise and advertising bureau, Class Journal Co., New York City, (mail) 95 Fort Street, West, *Detroit, Mich.*

ARMSTRONG, FRANK T. (A) sales engineer, Detroit branch, Wagner Electric Mfg. Co., 1291 Woodward Avenue, *Detroit, Mich.*

ASCH, B. M. (A) president, Asch & Co., Inc., 16 West Sixty-first Street, *New York City.*

BALDWIN, JAMES E. (M) chief engineer, College Point Corporation, College Point, N. Y., manager, New York City office, Buffalo Gasoline Motor Co., Buffalo, N. Y., (mail) Woodview Road, *Hempstead, N. Y.*

BAXTER, HAROLD A. (M) metallurgical engineer, Tacony Steel Co., Tacony, *Philadelphia, Pa.*

BECK, RALPH F. (J) assistant engineer, S. D. Waldon & E. H. Sherbondy, *Detroit, Mich.*, (mail) 485 Ashland Avenue.

BILLINGS & SPENCER CO., (Aff.) *Hartford, Conn.* Representatives: L. G. Bayrer, mechanical engineer; J. H. G. Williams, metallurgical engineer.

CARRON, HAROLD G. (A) salesman, Electric Storage Battery Co., Philadelphia, Pa., (mail) 1158 Cass Avenue, *Detroit, Mich.*

CHICAGO BEARINGS CO. (Aff.) 2341 Wabansia Avenue, *Chicago, Ill.* Representative: Charles A. Winn, president and manager.

CLARK, JOSEPH E. (A) automotive transportation engineer, Standard Oil Co., 200 Bush Street, *San Francisco, Cal.*

COLLINS, JOHN MATHEWSON (M) assistant treasurer and general superintendent, Moore Drop Forging Co., 336 Birnie Avenue, *Springfield, Mass.*

DATO, EDWARD A. (M) assistant experimental laboratory engineer, tractor works, International Harvester Corporation, *Chicago, Ill.*, (mail) 825 East Forty-ninth Street.

DE GUICHARD, BASIL W. (A) assistant general manager, Champion Ignition Co., *Flint, Mich.*

DICK, WILLIAM F. (S. E.) student, Armour Institute, *Chicago, Ill.* (mail) 1429 South Keeler Avenue.

EASTON, ROBERT D. (J) designer and draftsman, Monarch Tractor Co., *Watertown, Wis.*

EVANS, WILLIAM A. (A) traveling sales representative, English & Mersick Co., *New Haven, Conn.*, (mail) 189 Dwight Street.

FOSTER, FRANK M. (A) selling agent, 980 Jefferson Avenue, *Detroit, Mich.*

FREEMAN, TALBOT O. (M) advertising engineer, New Departure Mfg. Co., *Bristol, Conn.*, (mail) 143 Grove St.

FRIEDRICH, CHARLES P. (J) aeronautical draftsman, Naval Aircraft Factory, *Philadelphia, Pa.*, (mail) 4200 North Reese Street.

GEBHARDT, LIEUT. CHARLES I. (A) transportation officer, U. S. Naval Training Station, *Great Lakes, Ill.* (mail) Main Garage.

GRIFFEY, BERNARD E. (A) secretary and treasurer, Bernard E. Griffey Motor Supply Co., *Indianapolis, Ind.*

GROTTS, FRED (M) chief metallurgist and specification engineer, Holt Mfg. Co., *Peoria, Ill.*

GUTHRIE, ROBERT G. (A) sales engineer, Wood Equipment Co., *Chicago, Ill.*, (mail) 5302 Calumet Avenue.

HUBLEY, FRANCIS CURTIS (M) engineer sales department, Autocar Co., Ardmore, Pa., (mail) P. O. Box 452, *Cynwyd, Pa.*

KEIHN, CHARLES A. (A) inspector of engineering materials, aeronautic division, U. S. N., New York City, (mail) 340 Clifton Place, *Brooklyn, N. Y.*

KERN, WALTER C. (A) secretary and construction designing engineer, Wm. G. Hesse & Son Mfg. Co., *Leavenworth, Kan.*

KNAUSE, CHARLES E. (A) foreman, truck service department, S. D. Bausher Bleach Works, *Hamburg, Pa.*, (mail) P. O. Box 165.

LODEWYCK, SECOND-LIEUT. ARTHUR GEORGE (M) aviation section, Bureau of Aircraft Production, Fisher Body Corporation, *Detroit, Mich.*, (mail) 30 Adelaide Street.

MCCANN, ROBERT FRANKLIN (A) assistant purchasing agent, Dayton Metal Products Co., North Taylor Street, *Dayton, Ohio.*

MALLON, CAPT. WILLIAM H. (S. M.) motor transport officer, headquarters first division, Motor Transport Corps, (mail) A. P. O. 729, A. E. F., *France.*

MALYCHEVITCH, O. A. (M) assistant chief engineer, industrial department, All-Russian Central Union of Consumers' Societies, Inc., New York City, (mail) *Palisade, N. J.*

MENHALL, JAMES W. (A) president and general manager, Highway Trailer Co., *Edgerton, Wis.*

MICHIE, EDWIN R. (A) vice-president, Ordnance Engineering Corporation, 120 Broadway, *New York City.*

MILLING, COL. T. DEWITT (M) Division of Military Aeronautics, War Department, *Washington.*

MILLS, CHARLES GEORGE (M) sales engineer and head of sales and service school, General Ordnance Co., *Cedar Rapids, Iowa.*

MONGIARDINO, JAMES A. V. (A) Chipman, Ltd., 10 Bridge Street, *New York City.*

MURPHY, RICHARD J. (A) general manager and treasurer, District Oakland Co., 1828 L Street, N. W., *Washington.*

NATHAN, WALTER S. (J) development engineer, Cutler-Hammer Mfg. Co., *Milwaukee, Wis.*, (mail) 602 Frederick Avenue.

OLIVER, WILLIAM J. (A) president, William J. Oliver Mfg. Co., *Knoxville, Tenn.*

OLIVIERE, HENRY, (A) layout man, International Shipbuilding Co., *Pascagoula, Miss.*, (mail) P. O. Box 327.

PALM, GEORGE H. (J) machine designer, Page Co., *Chicago, Ill.*, (mail) 1444 Carmen Avenue.

PEPER, WALTER S. (J) 469 Fourth Avenue, *Long Island City, N. Y.*

PETERSON, CARL H. (M) president, Iron Mountain Co., 927 East Ninety-fifth Street, *Chicago, Ill.*

PROSSER, S. T. EDWARD (F. M.) assistant works engineer, engine factory, White & Poppe, Ltd., Coventry, England, (mail) Hampton in Arden, *Birmingham, England.*

REED, LEON H. (M) chief draftsman,, American Ball Axle plant. Standard Parts Co., Cleveland, Ohio, (mail) 1256 Donald Avenue, *Lakewood, Ohio.*

RITZER, WILLIAM G. (J) chief metallurgist and tests engineer, Salisbury Axle Co., *Jamestown, N. Y.*, (mail) 241 Fulton Street.

ROBERTSON, WALTER E. (A) inventor and president, Robertson Cradlelock Wheel Co., 53 West Jackson Boulevard, *Chicago, Ill.*

ROGERS, BURR S. (A) inspection superintendent, Curtiss Aeroplane & Motor Corporation, *Buffalo, N. Y.*, (mail) 19 Durham Avenue.

ROGERS, THEODORE N. (A) superintendent, Kimball Motor Truck Co., 1700 East Ninth Street, *Los Angeles, Cal.*

ROSSITER, WYNN F. (J) metallurgist, McKinnon Industries, Ltd., *St. Catharines, Ont., Canada.*

SCHWARTZ, HARRY A. (J) assistant engineer, Defiance Machine Works, *Defiance, Ohio*, (mail) 336 Holgate Avenue.

SHILLING, DAVID W. (A) Cincinnati Chevrolet Motor Co., Cincinnati, Ohio, (mail) 216 McGraw Avenue, *Grafton, W. Va.*

SHOEMAKER, J. H. (A) service manager, Ericsson Mfg. Co., *Buffalo, N. Y.*

SWIFT, FRED H. (A) service manager, Franklin Motor Car Co., 834 Union Street, *Utica, N. Y.*

VOUGHT, CHANCE M. (M) president and consulting engineer, Lewis & Vought Corporation, Webster and Seventh avenues, *Long Island City, N. Y.*

WALKER, JOHN (J) draftsman, International Motor Co., New York City, (mail) 9419 127th Street, *Richmond Hill, N. Y.*

WATTERSON, C. E. (A) president and general manager, Sheffield Machine & Tool Co., *Dayton, Ohio.*

WELLER, GLENN (J) 721 Division Street, *Defiance, Ohio.*

WHEELER, ARTHUR W. (A) general superintendent, Plant No. 3, Allen Motor Co., *Bucyrus, Ohio.*

WHITTET, A. B. (S. M.) draftsman, artillery division, Ordnance Department, (mail) B-1-118, Sixth and B Streets, *Washington.*

WIEDERHOLD, OSCAR, Jr. (A) electrician, 4531 Pulaski Avenue, *Philadelphia, Pa.*

WINCHESTER, J. F. (M) automotive engineer and equipment manager, Standard Oil Co., 31 Clinton Street, *Newark, N. J.*

WORDEN, VAN C. (A) engineer, Stromberg Motor Devices Co., 9 West Sixty-first Street, *New York City.*

YOCOM, ALVIN M. (A) chief draftsman, North American Motors Co., *Pottstown, Pa.*, (mail) 955 Queen Street.

YOUS, CHARLES R. (A) selling agent., 1408 Ridge Avenue, *Evanston, Ill.*

Book Reviews *for* S. A. E. Members

This section of THE JOURNAL contains notices of the technical books considered to be of interest to members of the Society. Such books will be described briefly as soon as possible after their receipt, the purpose being to show concisely the general nature of their contents and to give an estimate of their value.

POWER WAGON REFERENCE BOOK FOR 1919. Edited by Stanley A. Phillips. Published by the Power Wagon Publishing Co., 544 Lake Shore Drive, Chicago, Ill. Cloht, 8½ by 12 in., 368 pages, numerous illustrations. Price $2.50.

This book, which is the first of what is expected to be a series of annual publications, is a handbook of practical information for makers, sellers and owners of motor-driven vehicles for commercial and agricultural purposes. It has been prepared to give concise information covering motor truck design, equipment and economic performance and comprises a review of the vehicles in different trades with facts relating to their economy and efficient operation and complete tabulated specifications of power wagons, farm tractors, trailers and various parts. The information is presented in compressed form and at a length in proportion to the importance of the individual subjects.

The book is divided into seven sections, the first of which contains tabular specifications of the various gasoline engine-driven trucks. This is followed by a series of full-page blueprint drawings showing plan and elevation views of the trucks. These prints are designed to give dealers and purchasers a comprehensive view of the characteristics of the different lines of trucks without making the drawings complicated by any attempt to include the finer engineering details. In conjunction with the specification tables in the previous section the blueprints should enable a fairly comprehensive idea of the properties and capabilities of the different trucks to be secured. This section is followed by similar drawings for various types of trailers and electric trucks and the same arrangement of tabular specifications supplemented by blueprint drawings is followed for the farm tractors. The last division of the book is an encyclopedic text section in which numerous tables on subjects related more or less intimately to the different phases of motor-truck transportation are included. To facilitate the finding of any particular subject elaborate use is made of cross references, thus eliminating any necessity for a numerical page index. Among the subjects covered by the various tables are wheel speeds for different vehicle speeds, speed ratings of solid tire trucks, body weight allowances, weights, cubic dimensions and angles of repose for various materials that are handled by motor trucks, etc. In this section of the book an elaborate table of dimensions of various bodies supplements the text matter and the illustrations of the different kinds of bodies that are in regular use. The various trade names of the different products required for the building and equipment of motor trucks, trailers and farm tractors are given with the names and addresses of their manufacturers. In addition to this list of trade names in the text section of the book, a classified list of the manufacturers of these products is included at the end of the volume.

LOCATION OF STARTING AND LIGHTING SYSTEM FAULTS. Arranged by Victor W. Pagé. Published by the Norman W. Henley Publishing Co., 2 West Forty-fifth Street, New York City. Folding paper chart, 24 by 38 in. Price 50 cents.

This chart has as its central feature a typical drawing of an automobile, showing the various parts of the starting and lighting systems located in their proper positions on the car and the connections between them. Details of the various members are given in a series of enlarged drawings which surround the central engraving. Diagrams of the one-unit one-wire and the two-unit two-wire systems are also given. Instructions on the use of the chart are presented together with a series of hints for locating trouble. This is followed by a list of the various defects occurring in component parts of the system, the cause of the trouble and the remedy. Instructions on the care and adjustment of the batteries, motor, generator, ignition coil and circuit-breaker are given. In connection with the starting and lighting systems the different manifestations of trouble are given with the various causes grouped under each head and instructions for correcting the fault.